# RETRAINING ATTENTIONAL BIAS TO UNHEALTHY FOOD CUES

by

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# ABSTRACT

Title of Dissertation: Retraining Attentional Bias to Unhealthy Food Cues

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Obesity is the second leading cause of preventable death in the United States. Environmental cues encourage overeating by biasing attention for salient stimuli, which increases food craving and food intake. Addiction research has identified attentional bias (AB) to salient cues as a precipitant of craving and use/relapse. In light of evidence that similar mechanisms underlie drug addiction and obesity, strategies such as attention retraining (AR) that are used to reduce drug intake may apply to the study of obesity. Although there are countless food cues in the environment, reducing attention to certain types of food cues (e.g., modifying attention to cues for unhealthy food) may be possible using a cognitive computer task. Given the success of AR in other clinical conditions, the purpose of this study was to evaluate AR as a means of modifying attention to salient food cues.

Obese (n=36; body mass index (BMI) 36.33±5.98 kg/m$^2$) and healthy weight (n=43; BMI 22.20±2.14 kg/m$^2$) women completed a single two hour laboratory session

one hour post-lunch. Participants were randomly assigned to complete either an AR task that focused attention away from high-calorie and toward low-calorie food cues or a matched control task (no-AR). AB was measured pre- and post-training (standard visual probe task) and a taste test of four foods varied in palatability was completed post-training.

Taking ethnicity into account, AB for unhealthy cues was modified by training group between assessments, ($F(1, 74) = 3.960$, $p = 0.050$) reflecting a change in AB index scores between pre and post training among obese ($p = 0.023$) but not healthy weight ($p = 0.109$) women who completed AR. There were no weight or attention group differences in craving or food intake ($p$'s $> 0.05$). Retraining attention toward healthy food cues may have utility as a strategy for modifying AB to unhealthy food cues in obese women. Larger-scale laboratory and ecological momentary assessment studies providing for multiple sessions of AR are warranted.

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## DEDICATION

*This work is dedicated to my cousin, Katherine Serafin, a young woman with limitless potential and unending inner strength, taken far too young.*

*If God never puts more on us than we can handle,*

*then God must think you're a badass.*

Rest in peace, sweet angel. We will miss you forever.

February 19, 1999 – December 29, 2013

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# CHAPTER 1: BACKGROUND

## INTRODUCTION

Despite a worldwide concern in weight management (195), obesity rates have doubled since 1960. Obesity is the second leading cause of preventable death and represents an immediate public health problem (171). Currently available obesity prevention and treatment strategies are successful short-term, however, relapse to overeating and weight regain remain problematic (232). Successful weight loss maintenance is adversely affected by several external cues that stimulate eating in the absence of hunger, including social gatherings, advertisements/media, and mere exposure to palatable foods (32; 166). Surgical and pharmacotherapeutic interventions can reduce weight more than many behavioral options, but even these "last-resort" treatment options are unsuccessful at preventing weight regain from overeating. To prevent overeating and weight gain, strategies that target cognitive-motivational responses to food cues are needed because of the overwhelming presence of palatable food cues in the modern environment (31). Given the vast scope of the obesity crisis, there is a critical need for practical and affordable prevention and intervention strategies that effectively reduce overeating in response to environmental triggers. It is therefore important to better understand the cognitive mechanisms, such as attention, that underlie overeating among obese individuals in order that more effective strategies can be developed.

The present research was the first to test the utility of attentional retraining (AR) as a strategy for modifying attentional bias (AB) to palatable food cues. AR is a strategy that has successfully been employed in the addictions but has not yet been used to modify

attention to salient food cues. This study administered a single session of AR (or no-AR control training) to satiated healthy weight and obese women to train attention away from high-calorie and toward low-calorie food cues (AR group only). This proposal extends a model of drug addiction by Franken that identifies attention to salient cues as a precipitant of craving and use/relapse to the study of obesity (**Figure 1**) (23; 50; 236; 242). AB and food craving were measured pre and post-AR, and post-AR palatable food intake was quantified.

**Figure 1** outlines the model based on Franken's model of addiction (84). Salient environmental cues orient attention to food, leading to food craving and food intake. Among obese individuals, it is hypothesized that salient cues can lead to food craving and food intake when satiated, overriding physiological signs regulating feeding. The following sections guide the reader through the model. These sections provide a selective overview of (1) the role of genetics and environment in the current obesity crisis; (2) commonalities between addiction and obesity and rationale for use of the model; (3) AB, food craving, and food intake in obesity; and (4) AR.

## THE OBESITY CRISIS

### Definition of Obesity

'Overweight' and 'Obese' describe levels of body fat (i.e., adiposity) that exceed ranges of weight that are considered healthy for a given individual. The most common index used to measure adiposity is body mass index (BMI), which is calculated as weight in kilograms (kg) divided by height in squared meters ($m^2$) (46). BMI is divided into ranges for underweight, normal weight and obese. According to the National Heart, Lung, and Blood Institute (NHLBI) guidelines (164), healthy weight is defined as having

a BMI of 18.5 – 24.9 $kg/m^2$, overweight is defined as BMI of 25 – 29.9 $kg/m^2$, and obese is defined as a BMI $\geq$ 30 $kg/m^2$. Obesity is the result of chronic energy imbalance (calories consumed exceed calories expended) that leads to an accumulation of excess body fat. Obesity is further divided into Class I (30.0 – 34.9 $kg/m^2$) and Class II obesity (35.0 – 39.9 $kg/m^2$) and Class III obesity ($\geq$ 40 $kg/m^2$, also known as morbid obesity). It is common in the literature for individuals with a BMI $\geq$ 25 $kg/m^2$ to be classified as either overweight or obese due to an increased risk of weight-related health problems once BMI exceeds 25 $kg/m^2$. For the purposes of this literature review, overweight and obese refer to the NHLBI guidelines, 25 - 29.9 $kg/m^2$ and $\geq$ 30 $kg/m^2$ respectively.

***Prevalence***

Overweight and obesity are no longer the exception in the United States but are categories that describe more than two-thirds of adults (68%) 20 and older (81; 82). The rate of obesity is predicted to increase to 41% by 2015 with up to 75% of adults overweight or obese (243). The burden of obesity is not evenly shared across individuals, with rates of overweight and obesity highest among non-Hispanic blacks (74%), and more specifically women (78%) (82).

***Etiology of Obesity***

As rates of overweight increase, fewer individuals show the ability to self-regulate intake over long periods of time. Physical activity and diet fail to adequately explain the alarming rates of obesity (61; 88; 96). A combination of genetic and environmental factors likely explain the heterogeneity of obesity across individuals (257).

***Role of Genetics***

Variance in BMI is greatly affected by genetics. Population heritability estimates range as high as 40-70% (20; 47). Evidence from twin and adoption studies demonstrates the important role of genetic factors in determining those who are more likely to develop obesity in a given environment (151). It is important to note that an abundance of factors (e.g., neurotensin, orexin, neuropeptide Y, leptin) contribute to the control of energy balance at the cellular level and are directly applicable to the study of genomics in obesity (140). However, discussion of signaling mechanisms is beyond the scope of the current focus, which is specific to genetic variants that affect the development of obesity. Genomic studies have resulted in the identification of over 40 loci of the human genome related to obesity (153; 212; 267). It is feasible that a large portion of the variation in adult bodyweight in the current energy-rich environment is due to genetic factors, albeit allowed to thrive due to the presence of environmental triggers.

For example, the *TaqI* A1 allele has been associated with greater food craving, increased motivation to eat, and higher risk for obesity (52; 65; 227). However, findings of elevated BMI among persons who have the *TaqI* A1 allele are inconsistent (211; 227). With regard to cue-induced craving and motivated behavior, cigarette smokers and heroin addicts with the genetic polymorphism are consistently more likely to report more craving and abuse substances compared to individuals without the *TaqI* A1 allele (67; 143). This represents a genetic parallel between mechanisms that underlie motivational processes in addiction and obesity.

Epigenetic research suggests that the human genome dynamically responds to changes in the environment by altering gene expression. Toxins, such as cocaine, trigger

epigenetic changes in hundreds of genes in the brain (136) and some of the long-term effects of addiction (e.g., dependence, relapse) may be hardwired in epigenetic code (136). The state of the United States food supply is constantly in flux, and may initiate genomic changes that promote addictive behaviors unseen in previous decades. Although genetic discoveries are compelling, the genetic makeup of populations changes too slowly to be accountable for the rapid rise in obesity seen in the last generation. This suggests heightened responsiveness to food-related cues in the environment in some individuals.

***Role of Modern Environment***

The precise pathophysiology of obesity is unknown. Individual differences in food preferences, as a consequence of either genetic or experiential factors, may increase one's vulnerability to overeat when presented with pleasurable food stimuli. In particular, an increase in energy intake, rather than a decrease in energy expenditure, is posited as the lifestyle factor that best accounts for the increased obesity prevalence (260). The emergence of a 'toxic' environment with readily-available highly palatable foods has coincided with increases in obesity rates since the mid-1970s (115).

Exposure to the "toxic food environment" (40) of processed foods and reduced physical activity in the U.S. promotes weight gain through excessive consumption of palatable foods that contain large amounts of fat and sugar. Processed foods such as those from fast food establishments are high in fat and sugar, heavily consumed, and are linked to consumption of high fat diets and high BMI (124). There is a need for preventive measures that target intake of high fat and high sugar foods. Preventing and reducing the prevalence of obesity has been complicated by the more than two-fold increase in fast

food restaurants over the last 30 years, while the number of other restaurants have not risen at the same rate (49).

Individuals who manage their weight in an obesogenic environment demonstrate a remarkable ability to match intake and expenditure long-term. As rates of obesity increase, fewer individuals show the ability to self-regulate intake over long periods of time. This phenomenon suggests individual variability in the responsiveness to environmental food-related cues (180; 226) and further provides rationale for development of treatments that promote sustained weight management.

***Palatability: Defining the term***

A palatable (good-tasting) diet is ordinarily sought to satisfy hunger or thirst assuming no abnormality is present affecting such normal desires (202). The effect of palatability on satiety can be assessed by measuring test meal intake following preloads varied in their hedonic properties. The effect of palatability on intake, however, is best evaluated by measuring ad libitum consumption of foods whose hedonic properties are manipulated. The definition of palatability as it is used here is the perceived hedonic value of a food. This is not an intrinsic characteristic and varies between individuals as well as within an individual across meals.

Using only palatable or preferred foods, Yeomans (271) reviewed the effect of taste on intake and found numerous studies report an increase in meal size, duration, eating rate, and hunger ratings with increasing palatability of foods.

Liking for sweet taste is an innate response. Pleasant tastes help mask tastes that are unpleasant or not preferred. In the past the disaccharide sucrose (glucose + fructose),

or either of the component parts of this molecule have been the primary focus of study when assessing the preference for sweet over nonsweet solutions in both humans and rats.

Brala and Hagan (38) evaluated the effect of sweet taste on satiety by eliminating the perception of sweetness with gymnemic acid. They found subjects whose taste was affected consumed less test meal after a sweet-tasting preload than participants whose taste sensitivity was intact. The authors suggest a sweet oral stimulation initiates reflexes that increase appetite. One well-established finding is that hyperphagia results from consistent consumption of a high-sugar diet.

***Palatable Foods and Obesity***

Human beings are naturally inclined to seek out sugar *and* fat, yet no naturally-occurring foods are high in both sugar and fat. In the modern environment, all foods that are high in both are synthetic, available only as a product of engineering (213). Not only are certain foods innately sought, they are naturally rewarding and neurobiological mechanisms reinforce liking and wanting to encourage repetition. There is evidence that obese individuals prefer palatable foods and histories of dieting and weight-cycling are associated with heightened hedonic preference for palatable foods (for review see 163; 196).

Obese participants have been found to prefer higher amounts of fat (> 34% lipid) in their food compared to healthy weight (20% lipid) participants (60). This enhanced hedonic response to high fat foods among obese individuals has also been proposed as a potential mechanism of obesity (59). Compared to sweet taste preference, which is innate (27), a preference for fat appears to be at least partly due to learned associations between eating fat and feeling full. In rodents, early feeding history has played a critical role in the

development of fat preferences. Further, preferences prove resistant to change following a forced shift to a reduced fat diet (247). It is possible that fat preferences are environmentally induced during youth and once developed will resist obesity prevention strategies. Preference for fat in the current environment greatly increases risk for obesity given the abundance of calorically-dense foods available.

Several studies have investigated the effect on behavior and neurochemistry of foods high in sugar, high in fat, and synthetic foods that contain large amounts of both. There is convincing evidence in both rodents (10-19; 184) and humans (51; 57; 116) that binge eating on sugar induces behavioral (12; 16; 18) and neurochemical (50; 51; 116; 184) indicators of physical dependence that impede long-term treatment success. Withdrawal from a high-fat diet induces neurochemical responses that are similar to withdrawal effects experienced during drug withdrawal (148). Among individuals who binge repeatedly on sugar, removal of sugar can lead to headaches, dizziness, mood swings, anger, depression, fatigue, nausea, teeth chattering, cravings, insomnia, leg cramps. These symptoms are due to reduced stimulation of mu-opioid receptors that eliminate pain and cause euphoria and a precipitous drop in dopamine levels (51; 116). Individuals vulnerable to sugar experience dramatic spikes in dopamine after exposure to sucrose following abstinence, which makes relapse both psychologically and neurochemically detrimental. The experience of withdrawal is only present in some individuals, and the precise molecular or experiential mechanisms that regulate sugar sensitivity remain under investigation (68; 98).

One suggestion is that there are addictive properties in food that facilitate overeating and subsequent weight gain (91). Uncontrolled intake of palatable food can

lead to excessive use of food, psychological and physical effects when food is not present, and an increased risk of becoming obese due to overeating. Uncontrolled, or compulsive, eating behaviors may therefore be considered addictive if they are persistent and subjectively damaging physically or psychologically. In the scientific literature, this compulsive pattern of eating despite marked negative consequences has been identified as food addiction (91). The idea of food addiction has received mixed support from research and clinical communities in large part because there is overlap with clinical eating disorders, such as binge eating disorder, that make standardizing definitions of food addiction difficult. Some of the literature has been anecdotal, such as the notion that negative mood can occur when starting a low-carbohydrate diet (e.g., Atkins diet), supported by a single case study (62). Additionally there is a small amount of research studying chocolate addiction and the consensus at present is that self-reported chocolate addicts respond to drug cues similarly to drug addicts but lack many characteristics of clinical eating disorders (231).

In the popular language, the term "food addict" has several meanings. Terms that are used interchangeably with food addiction in lay literature include: emotional eating, compulsive eating/overeating, and binge eating. It is difficult to differentiate "compulsive overeating" and "food addiction" given that many individuals in recovery as well as clinical professionals use the terms interchangeably. Consequently, no standardized definitions of food addiction exist and food addiction has received little support from research or clinical communities in large part because there is no evidence that food addiction is different from binge eating disorder. Some researchers have viewed food addiction in light of eating disordered behavior, noting that substance dependence criteria

for loss of control over food intake and inability to stop/reduce intake mimics diagnostic criteria for eating disorders (97). Food addiction has been compared to behavior seen in binge eating disorder (continuing to eat unhealthy foods in the face of adverse consequences) and bulimia nervosa (tolerance to food) and the majority of researchers do not yet accept the concept of food addiction (24).

Recently, the first self-report measure was developed to assess food addiction, based on DSM-IV-TR substance dependence criteria. The Yale Food Addiction Scale (YFAS) (91) has demonstrated an association between food addiction and other aberrant eating behaviors (binge eating, emotional eating, and external eating) in samples of college undergraduates (91) and women in a weight management program (92). In one recent neuroimaging study, food addiction symptoms assessed with the YFAS were associated with neural activation in response to cues signaling delivery of a palatable (chocolate milkshake) or bland (tasteless) solution among healthy weight and obese women in a weight management study (92). Self-reported food addiction scores were associated with areas of the brain that encode motivational value of anticipated reward. Further, food addiction scores were positively correlated with activity in the medial orbitofrontal cortex during anticipation of food reward and negatively correlated with activation in the lateral orbitofrontal cortex during receipt of food, a region of the brain involved in inhibition, suggesting poor inhibitory control in individuals with high YFAS scores, irrespective of BMI (92). This finding is consistent with the initial validation of the YFAS in college students (91). Results suggest that food addiction, or a feeling of chemical dependency on certain foods that promotes craving and use, does not only occur in obese individuals.

Preventing overeating large amounts of sugar could prevent neurochemical changes in the brain that impede dietary modification. In order to combat the widespread effects of the American food environment, the clinical and research community are challenged to develop multi-faceted interventions that target cognitive processes that underlie overeating.

***Health Consequences of Obesity***

Obesity is an international concern and is becoming not only difficult to prevent but nearly impossible to treat. Risk of weight-related health problems increases progressively with BMI and the majority of serious consequences are associated with obesity rather than overweight. Individuals with BMI > 25 $kg/m^2$ are at higher risk for weight-related diseases, such as high blood pressure and dyslipidemia. Obesity is also associated with the development of type 2 diabetes, heart disease, osteoarthritis, and some cancers, and excess weight is associated with complications during pregnancy and premature death (46). Adults who are obese are more likely to report high stress (29%) compared to healthy weight adults (20%) and are more likely to rate their health as a contributor to their stress (65% vs 38%, respectively) (7).

Fortunately, many of the risks associated with obesity can be reduced with small to moderate weight loss (167). Further, the health benefits of moderate weight loss continue as long as weight loss is maintained. Although risk of comorbidities decreases with weight loss and remains low as long as weight is kept off, the major challenge in reducing prevalence rates of obesity is the failure to maintain weight lost using currently available behavioral interventions (159).

## Current Approaches Fail to Prevent and Treat Obesity

Given the elevated risk profiles that are associated with excess weight, the U.S. Healthy People 2020 project has outlined specific objectives for reduction of obesity prevalence in all age groups. Through Healthy People 2020, the U.S. Department of Health and Human Services (DHHS) proposed that nutrition and weight loss intervention efforts should aim to 1) increase the proportion of adults who are at a healthy weight; 2) reduce the proportion of adults who are obese; and 3) prevent excess weight gain in youth and adults (1). Current approaches are largely unsuccessful at assisting individuals with weight maintenance long-term. This makes it unlikely that DHHS objectives for 2020 will be met unless additional strategies are developed.

### *Physical Benefits of Moderate Weight Loss*

Weight loss can have a major effect on health risks. Losing weight requires a decrease in energy intake (dietary change) and an increase in energy expenditure (physical activity) in order to shift the balance between calories consumed and expended over time. Moderate weight loss of 5-10% is associated with an improvement in cardiovascular and metabolic risk profiles, however, there is minimal long-term weight loss success from lifestyle interventions with frequent weight regain over time (233).

### *Failure of Currently-Available Weight Management Interventions*

Currently available weight management treatments have success only short-term (< 12 months) (232), and weight regain to and beyond pre-diet weight is common (122; 187). Long-term weight management remains a problem and the majority of lost weight is regained within 1 to 5 years (42; 238; 239). Regaining lost weight has been associated with adverse physical and psychological symptoms (87). Maintaining weight loss can be

done, however, and data from the National Weight Control Registry (NWCR; 127) reports that nearly all (88%) of successful weight loss maintainers restrict certain foods as a strategy for successful control of body weight. Maintenance of weight loss is possible with careful control of calorie intake and regulation of types of foods consumed.

Better methods are needed to assist with achieving and maintaining modest weight reduction. The patients that benefit from weight loss is limited by the difficulty in maintaining lost weight long-term.

***Factors that Undermine Long-term Weight Loss***

Long-term success in behavioral weight loss studies is undermined by internal and external cues that stimulate overeating and weight regain (32; 166). Following weight loss, physiologic adaptations in neuropeptide Y (201), leptin (193), and thermogenesis (194) oppose efforts to maintain reduced body weight, driving the urge to overeat palatable foods in response to cues other than hunger.

Internal factors, such as negative emotions and stress (3; 123; 197; 244), lack of social support in weight reduction efforts (228), and anticipation of caloric deprivation characteristic of dieting (146) further interfere with long-term success. Environmental and behavioral factors that encourage overeating include social situations (112; 197), increased TV viewing (186), and viewing tempting or craved foods (112; 173; 244).

Efforts to lose weight by adhering to reduced calorie diets and restricted intake of palatable foods are often impaired by reverting to patterns of overeating. Internal and external cues undermine long-term weight-loss success and increase food intake and risk of weight (re)gain (32; 166). However, behavioral treatments rarely focus on the subversive nature of context cues that sabotage weight loss efforts. New approaches are

needed to counteract the impact of cues in the environment so that the benefits of moderate weight reduction can be achieved by more individuals.

Although numerous commercial weight loss programs are widely available, data indicate that effectively regulating eating is influenced by external cues. Therefore we must change our approach to weight management by implementing strategies that serve not only to modify eating behavior but the cognitive processes that underlie overeating in response to salient cues. In order to decrease the impact of external cues in the environment, 1) prevention and treatment strategies must be developed that interfere with attention to cues that promote overeating, 2) there must be a means of measuring the success (or lack thereof) of attentional interference, and 3) level of success must have external validity and be able to affect liking and wanting for palatable foods.

## Underlying Mechanisms of Obesity and Addiction

There has been increased interest in the past decade in better understanding cognitive processes that underlie addictive behavior and relapse (266). However, the underlying mechanisms involved are largely unidentified. High rates of relapse are observed in both addiction treatments and weight-management programs. There are noticeable behavioral similarities between overeating and classic substance dependence. In both conditions, a key problem is the repeated intake of a substance with immediate and reinforcing effects, but adverse long-term consequences to physical and psychosocial health (237). Both drugs of abuse and food activate brain reward pathways in a similar manner (237). The same neural system involved in drug use and food intake is strongly involved in the pathophysiology of eating disorders including bulimia nervosa and binge

eating disorder, both of which include frequent overeating, often of palatable, high-sugar foods (125).

A number of addiction theories contend that substance-related stimuli will capture the attention of people who use or abuse an addictive substance. Early theorists assumed drug use was the result of a classically-conditioned response following repeated pairings of drug cues and drug effect. Prefaced by the concept of classical conditioning, incentive learning and incentive habit theories also sought to explain addictive behavior. The premise of the incentive learning theory is that incentives associated with a substance become more salient through repetition (161). As individuals become more conditioned to prefer a substance the amount needed to obtain the desired effect increases. Incentive-habit theory posits that addictions are classically conditioned through incentives and once the incentives become addictive, then the individual's behavior becomes habitual (161).

The above models of drug use serve to explain that repeated use of a substance strengthens the cognitive and behavioral responses to substance-related cues in the environment. These theories explain learned associations but do not explain a physiological mechanism by which environmental cues override internal regulation of eating behavior.

**Incentive Sensitization Theory**

One potential mechanism for explaining the failure of currently-available interventions for weight management has been put forward in the "Incentive Sensitization Theory" of addiction (189). The Incentive Sensitization Theory describes addiction to various drugs as the result of neural alterations that drive consumption (85; 111; 152; 256). The mesolimbic dopaminergic reward circuit is highly involved in addictive

behaviors. The reward circuit includes the ventral tegmental area that sends projections to the nucleus accumbens, amygdala, hippocampus, cingulate and prefrontal regions (237).

There is substantial evidence of reduced dopamine release during drug consumption, reduced dopamine D2 receptor availability, and weaker subjective reward in substance-dependent individuals (234; 236; 240) relative to healthy controls. These findings may reflect a down regulation of dopamine receptors caused by overstimulation of the reward system as a result of repeated, chronic use (241). An alternative is that reduced density of dopamine D2 receptors reflects an innate vulnerability to become addicted (235).

The Incentive Sensitization Theory hypothesizes that dopamine triggers attention toward drug-related stimuli via activation of reward pathways in the brain. This automatic capture of attention to a specific type of cue (i.e., AB) is involved in addiction (189; 214; 229). Use becomes associated with positive physiological, cognitive, and behavioral effects and the positive effects quickly become associated with drug cues. Dopamine release becomes dependent on drug use and attention becomes biased toward substance-relevant stimuli to encourage drug use. A 1999 meta-analysis of cue-reactivity research conducted among smokers, alcoholics, heroin addicts, and cocaine addicts revealed that exposure to drug-related cues consistently produced increases in subjective craving and physiological arousal (44). The conclusion from Carter & Tiffany's meta-analysis was that reactivity to drug cues is a primary feature of drug dependence (44). The Incentive Sensitization Theory similarly identifies attentional bias (AB) as an important component of dependence and relapse. Attention becomes biased toward

salient cues and the brain responds to salient stimuli by releasing excessive amounts of dopamine. Stimuli associated with drug-taking become highly attractive, 'wanted' and 'grab attention,' due to repeated substance use that sensitizes the brain (for review see 23). While 'liking' for a substance is high initially, with repeated use the substance and associated cues acquire salience (e.g., incentive salience/'wanting') and as the reward system becomes sensitized, 'wanting' for the substance increases but 'liking' is reduced. However, the sensitized neural system is also physiologically tolerant from repeated substance use and experiences chronic reduction of dopamine receptors available for binding.

With regard to food, energy intake is controlled by a cycle of hunger-satiety that is internally regulated, naturally repetitive, and fundamental to metabolic and neurochemical balance. This hunger-satiety cycle is affected by a variety of emotional, cognitive, environmental, and social variables (109). One such variable is attention to food cues and an enhanced food cue-reactivity has been demonstrated in both healthy weight and obese individuals when hungry (45; 169; 170). This AB is presumed to drive food consumption via the same mechanisms that AB to drug cues encourages drug use, dependence, and relapse. A similar hyperresponsivity of the dopaminergic reward system is specifically hypothesized among obese individuals in response to palatable food cues (23) because only obese individuals studied have demonstrated an AB to food cues in the absence of hunger (e.g., when satiated) (45; 170). The focus of the current research is on AB to food cues among obese women that lead to food craving and food intake despite a lack of self-reported hunger.

**Incentive Sensitization Theory of Obesity**

Palatable foods and drugs impact the brain via the same mechanisms (237); by altering processing regions of the brain to bias attention toward 'wanted' (i.e., salient) stimuli in the environment (23). Both drugs and food elicit similar withdrawal symptoms and dependence physically and psychologically (237). The incentive sensitization theory of obesity (23) posits that exposure to food and related cues among individuals with a heightened food cue-responsiveness (i.e., sensitized reward system) increases craving and likelihood of overeating (23; 180).

The modern 'toxic' environment (40) is proposed to promote intake of palatable foods by over activating dopamine circuits of the brain that process reward value, particularly among obese individuals. This effect on motivational processes is mediated in part by biased attention to salient stimuli in the environment (189; 190). Drug-seeking or overeating could be due to an innate deficiency in dopamine receptors or down regulation due to chronic receptor activation. Regardless the cause, the consequence is an altered neural response to reward value. And the same neurobiological mechanisms appear to underlie substance addiction, obesity, and potentially eating pathology such as food addiction/eating disorders (discussed above). Further, as Robinson and Berridge assert in the incentive sensitization theory, the dopaminergic reward system modulates 'wanting,' which is the motivational response to salient cues. Food cues that have acquired incentive salience may predispose some individuals with aberrant reward circuitry to overeat as a means of compensating for a reward deficit. For this reason, these 'reward deficient' (30) individuals are perhaps inclined to pursue more rewarding

stimulations, for example consumption of increasing quantities of palatable food to elevate dopamine.

**Franken's Model of Addiction**

Franken (84) expanded on Robinson & Berridge's model to describe the mechanism by which AB leads to drug use and relapse (84). Franken proposed that AB elicits craving, which leads to use and relapse. Craving has been described as both strong desire to self-administer a drug (269) and the result of dependence or abstinence manifested in increased efforts to obtain the desired substance (10). Food craving, described here as an intense desire to consume a particular food as opposed to simply consuming any type of food, is common for some individuals (192). There is a growing body of evidence that addicts exhibit an AB to drug-related cues, which is associated with drug craving (for a meta-analysis, see 79), drug use (69) and relapse (53; 152; 253). AB has been demonstrated in individuals addicted to a variety of substances, currently using or substance-abstinent, and those receiving or seeking treatment. Further, AB and craving form a cyclical relationship with each other that precedes relapse. Once recognized, craving further enhances AB yet craving does not occur independent of an AB to salient cues. Whereas AB is an unintentional and even subconscious process, craving is above the threshold of conscious awareness and together AB and craving motivate drug-seeking behavior.

Franken's conceptualization that AB and subjective craving are central concepts in the understanding of addictive behaviors is agreed with by several other contemporary addiction models (for a review, see 74). The neurobiological similarities between drug

addiction and obesity provide rationale for applying Franken's model to the study of obesity in the present research.

**Revised Neurocognitive Model of Obesity: Present Research**

The relationships between AB and craving have substantial support in the field of addiction (for a meta-analysis, see 79). Studies evaluating the differences in AB to food cues and relationship to craving between healthy weight and obese individuals are lacking. Understanding the role of AB and craving in food intake, and the relationship between these two constructs, is important for prevention and treatment efforts given the obscenely high rates of obesity and the current problems with treatment success.

Food cues command an overwhelming presence in the modern environment yet vary in how they affect people. This proposal seeks to test Franken's model of addiction to determine if craving is a mediator of the relationship between AB and food intake among obese individuals. Franken's model of addiction and the adaptation used here (**Figure 1**) are not presumed to apply to healthy weight populations. The model is assumed to apply to obese individuals because it is these persons for whom overeating is presumed to have resulted in altered reward valuation and dopamine release in response to palatable food cues regardless of hunger or satiety.

***Summary***

A number of models of addiction have been proposed, many emphasizing an association between abnormal dopamine release in the brain's reward areas and sensitized cognitive, behavioral, and subjective responses to substance-related stimuli (84; 86; 189). In particular, growing evidence indicates AB to substance-related cues

among substance-dependent individuals that are related to subjective craving and substance-seeking (for reviews, see 74; 79).

The incentive sensitization theory describes the etiology and maintenance of addictive behaviors, including obesity, as an alteration of neural circuits that regulate cognition, motivation, and behavior (23; 189; 190). This and other theories of addiction (44; 84; 161) explain how AB develops and the mechanism by which biased attention increases craving and food intake. Stimuli associated with overeating of highly palatable foods acquire high motivational salience due to a sensitization (i.e., hyperactivity) of the dopaminergic reward system. Alterations result from repeated food intake and mediate behavior through incentive salience to the food and all associated stimuli via classical conditioning.

A habitual pattern of eating develops that is motivated by external cues rather than internal signals to eat. It is not known if AB to unhealthy food cues can be modified among obese individuals or individuals at-risk for weight gain. Strategies that reduce attention to external cues may improve treatment outcomes among individuals who struggle to reduce consumption of high-calorie foods. Further, if public policy initiatives are successful in modifying the "toxic" environment, these same strategies may become important mechanisms for prevention of obesity as well. What follows is a description of situations in which AB is maladaptive and the role that AB plays in craving and overeating, particularly among obese persons.

## ATTENTIONAL BIAS IN OBESITY

### Definition of Attentional Bias

It is hypothesized that a core aspect of relapse may be related to living in an environment that is laden with appetitive cues that are salient and bias attention. An AB refers to the tendency to selectively attend to stimuli that have acquired salience, or meaning (155). An AB in response to salient stimuli occurs at the expense of other (neutral or less salient) stimuli. The process of focusing on specific cues, feeling a sudden urge or 'want' for that cue or a related item, and procuring the desired item activate both controlled (e.g., explicit, conscious) and automatic (e.g., implicit) psychological processes (198).

Explicit processes are typically effortful, controlled, and driven by conscious appraisal of events. These types of processes may be captured reasonably well by self-report (questionnaire) measures. In contrast, implicit processes are fast, automatic, and effortless. These processes are not unconscious processes but may or may not actively engage conscious awareness. It is not possible at the present time to assess implicit processes with self-report questionnaires. Self-report measures are explicit tests and at times require participants to provide private information or report on topics that are socially sensitive (i.e., racial bias). Additionally, explicit measures assume that participants are able to report private and/or sensitive knowledge accurately and that this ability is universal and similar across persons (102). However, a variety of computerized cognitive tasks derived from experimental cognitive psychology provide quantitative information from which theories about implicit processes are derived (251).

**Measurement of Attentional Bias**

Research using paradigms to study AB are most prominent in the addictions (for reviews, see 74; 79). Some research has extended the use of these paradigms to the study of eating (71; 139; 209) and obesity (45; 170; 258).

The most common direct measures of AB are the visual probe task (e.g., 76) the modified Stroop task (e.g., 252), and the attentional blink task (e.g., 249).

***Visual Probe Task***

The visual-probe task is the primary task employed for examination of attentional allocation to food cues. The visual probe task is often used because it provides a more direct measure of attention allocation to food cues than the Stroop (162). A modified version of the visual probe task is the primary paradigm used to train attention toward or away from salient cues. The visual probe task has successfully reduced AB to drug cues in addiction (see next section on AR), modifying craving and intake behavior in the laboratory (9; 76). The current research is the first attempt to use the visual probe task to measure and modify AB to palatable food cues, food craving, and acute food intake in obese adults.

In the visual probe task, a series of word or picture pairs are presented relatively briefly (typically 100-2000 ms), each pair consisting of a high-calorie food stimulus (e.g., picture of soda can or chocolate) and a neutral stimulus (e.g., picture unrelated to food, such as a paper clip or nature scene). After the stimuli disappear, a small dot (i.e., a probe) takes the place of one of the stimuli on each trial. Participants indicate where the probe occurred by pressing a response button assigned to the respective side of the screen (e.g., right or left). Attended, compared to unattended, regions of visual display generally

elicit faster responses (181). Response times to probes yields an index of AB to food cues relative to control cues.

Numerous studies have used the visual probe task to demonstrate AB in various psychopathologies, including anxiety (e.g., 150), drug addiction (for reviews, see 74; 79), smokers (35; 63; 250), cocaine addiction (85), and opiate addiction (147). Use of the visual probe task has also extended to the study of eating disorders (58; 204; 205) and obesity (45; 170; 258). AB differences between healthy weight and obese individuals using the visual probe task is limited and results are inconsistent as to whether OB and HW women differ in AB to palatable food cues when satiated (45; 170; 258).

## Attention Bias Motivates Craving and Food Intake in Obese Individuals

### Etiology of Attention Bias to Food

Both drugs and food, particularly refined carbohydrates and sugar, bias attention to salient substance-related cues in the environment. Both, therefore, are said to elicit AB (155). While AB to drug-related cues is maladaptive under any circumstances, an AB to high-calorie food cues developed as a mechanism of survival during times when food was scarce. The most common foods that draw attention are palatable foods, those that are calorically-dense and naturally sweet.

### Role of the Modern Environment in Attention Bias to Food

In the present-day environment, an individual's natural AB for sugar and fat is continually activated by a steady barrage of food-related stimuli. Although cravings for sugar and fat evolved as a means of survival in food-scarce environments, hyper-responsiveness to food cues in today's obesogenic environment contributes to overeating

and obesity. Due to the prevalence of potently rewarding foods, heightened AB of food stimuli is believed to be in large part due to the obesogenic environment that contributes to overeating, obesity, and inability to modify eating behavior long-term. The refined food addiction model (121) posits that through the industrial refining process that combines high concentrations of rewarding food additives (e.g., sugar, fat, caffeine, salt), the reward potency of the final food product is enhanced far above that of any individual ingredient. The effect of consuming refined foods is that large amounts of synthetic ingredients are ingested and reward pathways of the brain are chronically activated.

**Role of Hunger and Weight in Attention Bias**

An AB to food should be more pronounced in states such as hunger, when AB is appropriate (162). Further, an AB in an obesogenic environment is particularly inappropriate when one is satiated because there is no immediate physiological drive to encourage consumption (162).

Findings from studies employing a variety of paradigms over the last 20 years have demonstrated that AB for food is present in healthy weight and obese individuals when they are hungry (48; 160; 179; 219; 220). In healthy weight volunteers, enhanced AB towards food-related words on the visual probe task has been associated with subjective hunger (162; 179) and AB for food words has been found in fasted individuals with and without eating, weight, and shape preoccupations (162; 179). Placanica et al (179) proposed that AB findings cannot only be explained in terms on the basis of hunger because individuals who were preoccupied with weight and those who were not all focused attention toward high-caloric foods when hungry, whereas individuals concerned with weight also directed attention (e.g., showed AB) to low-calorie food words when

satiated (the others had no AB for food when satiated). Placanica's results demonstrate the power of cognitive processes in a satiated state to override homeostatic mechanisms that regulate hunger and satiety and affect attention. The presence of only a heightened AB for low-calorie (but not high-calorie) foods among healthy weight females with eating preoccupations suggests that attention is directed to different types of stimuli when hungry versus when satiated. Hunger therefore may be important in determining the type of foods that attract attention and an AB in the absence of hunger may be a sign of eating pathology, even among persons of healthy weight. There is no mention of preventive efforts targeting satiated healthy weight women with an enhanced AB in the literature. The majority of the above studies examined AB in the context of eating style or disordered eating behaviors but did not discuss AB or report differences in AB as a function of BMI and the relationship with overweight and obesity. To better understand AB among healthy weight and obese women, the present study included females with a BMI $\geq$ 18.5 kg/m$^2$. A subset of the sample in the present research were healthy weight to further not only research on strategies to prevent and treat obesity but as a means of better understanding AB and eating patterns among healthy weight individuals.

Participants were tested when satiated, within one hour following consumption of their usual lunchtime meal (215). Previous studies have shown that hunger elevates attention focus and craving for food independent of weight status (45; 162; 170; 178). Studying participants following mealtime was preferred because exposure to food-related cues among satiated individuals was presumed to increase food craving and likelihood of overeating due to a sensitized (i.e., hyperresponsive) reward system hypothesized among obese individuals (23; 180). Feeding participants in the laboratory has been used as a

means of satiating participants (45; 170; 258), however, there are problems with ensuring equal satiety across participants when providing liquid (45; 170) or solid (258) preloads to participants with varied metabolic needs.

Compared to studies that include healthy weight samples, there are fewer studies of AB specifically examining the response of obese persons to food cues (37; 115; 163; 170; 258; 272). Three studies in particular provide information from which the methods and background of the present methodology were based.

**Studies of Attentional Bias, Craving, and Food Intake in Obesity**

Studies have shown enhanced AB towards food cues in hungry versus satiated, and in obese versus healthy weight individuals in response to high-calorie versus neutral visual cues using the visual probe task (45; 170; 258). AB findings in these studies were based on eye tracking and/or ERP results, not visual probe reaction times. Studies using a visual probe task to compare satiated healthy weight and obese found no significant differences in AB between groups when cue presentation durations exceed 200ms (e.g., measure maintained vs oriented attention) (45; 170; 258). The usefulness of a visual probe task as a measure of maintained attention is questioned by some. However, it is important to study maintained attention using a visual probe task to learn whether retraining attention away from unhealthy food cues is "maintained" longer than 200ms.

In addition to AB differences between weight groups, craving and food intake vary by weight status. Levels of food craving are higher among obese compared to healthy weight women in response to food cues under conditions of satiety (258). Food craving among obese individuals is positively associated with a bias in initial orienting of

attention to high-fat foods using eye-tracking (258) and overeating during a bogus taste test when satiated (258).

Whereas the findings by Castellanos et al. (45) and Nijs et al. (170) support the existence of a bias in initial oriented attention toward food cues in overweight participants using eye-tracking (45) and a visual probe task (170), research findings are inconsistent regarding attentional shifts during maintained attention. There are reports of increased maintained attention (indicated as gaze time) for food cues in obese participants (45) and conflicting evidence using ERP, suggesting attentional avoidance away from food cues among overweight individuals (170). Inconsistent results could be due, in part, to differences between research paradigms.

The visual probe task used in the current study is an extension of previous research on AB with healthy weight and obese women (45; 170; 258). AB research using food, weight, or body -related stimuli suggests that obese compared to healthy weight women have higher AB to food-related cues, however, this area requires further research.

The present study examined AB toward high-calorie food, low-calorie food, and non-food items in obese and healthy weight participants. Moreover, whether AB for food cues are related to reports of food-craving and whether craving mediates food intake was examined. The most novel extension of the present research was the use of AR as an attempted means of interfering with AB, to assess the impact on craving and acute energy intake.

**Definition and Prevalence of Food Cravings**

Food craving can be defined as an 'intense desire to consume a particular food item or type of food that is difficult to resist' (261). Craving overrides homeostatic

mechanisms that regulate hunger and satiety. While consumption of a wide variety of foods can assuage hunger, food cravings are alleviated by consumption of specific foods (177). Pelchat (174) found nearly all young adults of both sexes reported a conscious "urge for a certain food" in the previous year.

Cravings among women range from 2 cravings during a five-day period (113) to 4 cravings in a seven-day period (113; 114). Among these women, all cravings occurred after midday with two-thirds reported in the evening (113).

**Commonly Craved Foods**

Cravings for sweet/high-fat foods (e.g., palatable foods) are most commonly craved (114; 191; 255) and chocolate is the most commonly craved food reported among females but not among males (255). Not only are sweet and high-fat foods more commonly craved among females than males, obese people prefer high-fat/sweet foods and eat more of these types of foods than healthy weight persons (60). BMI has been associated with cravings for sweet foods (197) and with binge eating in self-reported cravers (93).

**Role of the Modern Environment in Food Cravings**

Environmental prompts such as seeing or smelling food or seeing food images bias attention and can elicit food craving (73; 176). In the present environment laden with food cues, it has been postulated that the ability to find and consume the craved substance encourages craving (95). This interpretation is contradicted by the argument that cravings are the result of biological needs that function to correct physiologic deficits (254). The idea that cravings develop as a mechanism to maintain homeostasis is appealing, however, empirical evidence lends more support to the hypothesis that environmental

triggers elicit craving. For example, studies show that restricting certain types of foods does not increase cravings for the restricted foods (105) and food deprivation is not essential for the occurrence of food cravings (114).

**Attention Bias, Food Cravings, and Food Intake**

AB and food craving are assumed to have a mutually excitatory relationship with each other (84), such that AB can trigger craving for food (79; 84) and craving enhances AB and leads to increased intake of high-calorie food among obese women (170).

Food craving plays a critical role in promoting food consumption and controlling food intake. The relationship between food cravings and food intake commonly relies on subjective reports of whether or not participants consume the foods they report craving. Among both men and women, it is estimated that approximately three-quarters of craving episodes result in eating (113; 255). The findings suggest that, more often than not, cravings lead to eating.

The high rate of indulgence in food cravings is extremely problematic given that food cravings interfere with adherence to weight loss regimens (224). In overweight dieters, food cravings are posited to play a role in poor compliance with low-calorie diets, resulting in relapse to overeating (29; 72). In addition, among non-clinical samples, cravings for high-fat foods are directly associated with increased BMI, and with elevated BMI among participants with type 2 diabetes (56), suggesting a negative yet pervasive influence of craving in food consumption and obesity (86; 261). Therefore, it was expected that body mass, food craving, and taste test energy intake would be positively associated in the present investigation.

**Definition of Eating Behavior and Overeating**

Eating behavior is characterized by repeated episodes of ingestion followed by intervals of postprandial satiety, defined as a reduced willingness to consume additional food (141). Research has consistently shown all calories are not created equal with respect to satiating efficiency. Macronutrient content (protein > carbohydrate > fat) (248), expectation of ingestion (245), and learned associations between flavors and caloric density of foods (246) demonstrate only some variability in the effect of caloric intake on satiety. Eating behavior is a complex phenomenon that encompasses a variety of components including response to bitter/sweet taste, meal size/frequency, and macronutrient preference (for review see 55). Additionally, eating is not regulated solely by internal mechanisms but is influenced by external variables, particularly AB.

Eating is a highly reinforcing activity (270), with variance across individuals in the level of reinforcement obtained from eating that affect types of foods consumed and overall energy intake (65). Just as the reinforcement associated with a drug is linked to drug use and differs across individuals (26), level of reinforcement associated with food is variables and is related to differences in food intake (66). As obesity is defined by excess intake, individual differences in the level of food reinforcement may bias some individuals to 'use' more than others. Although not a predictor of current BMI (182), AB to unhealthy food words using the Stroop task has been shown to predict 12 month increase in BMI, and participants with AB to healthy food words lowered BMI. Such findings support the idea that eating behavior is affected by AB for high-calorie foods.

Food may be more physiologically reinforcing to obese individuals, particularly under conditions of satiety, increasing motivation to eat despite less neurochemical

reward. Modification of AB could reduce overconsumption of influential (e.g., highly salient) foods that require ingestion of increasing quantities to elicit neurochemical release, particularly among obese individuals (43).

***Summary***

An AB to food cues is positively associated with food craving, food intake, and predicts relapse and weight gain (43; 175). Understanding the differences in AB to food cues between healthy weight and obese individuals is important for prevention and treatment efforts considering the ability of environmental cues to bias attention in the obese irrespective of hunger.

Using the visual probe task and eye-tracking, AB for food-related stimuli and subsequent food intake have been measured among obese and healthy weight women under conditions of hunger (45; 170) and satiety (45; 170; 258) When hungry, healthy weight and obese women both demonstrate an AB for food vs. neutral cues (45; 170). When fed, enhanced AB towards food cues is maintained among obese/overweight women when eye tracking and/or ERP is employed (45; 170) but conflicting results are obtained from visual probe task data.

This study replicated previous findings that showed an AB to high-calorie food cues among satiated obese women with eye tracking/ERP. Based on the models set forth by Robinson and Berridge (23; 189; 190) and Franken (84), both craving and AB to palatable food cues were anticipated to be higher among obese individuals.

The neurobiological mechanisms that promote AB are similar in the addictions and overeating and AB similarly predicts craving and relapse in both eating and drug use. High relapse rates and multiple 'quit' attempts remain common among dieters. A

generally reported trigger of relapse is an intense craving for the substance, leading to loss of control (89; 100).

Treatments interfering with AB to salient cues have primarily been conducted in the classical addictions. The current research adapted an AB-reduction strategy for use among obese individuals.

## Modification of Attentional Bias to Food among Obese

### Attentional Retraining

Understanding how implicit cognitive processes such as AB can be modified with strategies such as AR could inform prevention and treatment approaches for weight management. The present study examined the extent to which AB, food craving, and food intake are affected by a single session of AR using a visual probe task modified to train attention toward healthy food cues and away from unhealthy (high sugar/fat) food cues. This study was the first to test AR as a strategy for modifying AB to unhealthy food cues among healthy weight and obese women when sated. Effects of single-session AR have also altered self-reported craving and use in laboratory studies of smoking (9) and alcohol (75; 76). The impact of the AR paradigm on food craving and acute food intake was also assessed.

### Attentional retraining paradigm and procedures

The purpose of AR is to modify implicit processes such as attentional bias through cognitive training and is most often performed on a computer. The impact of AR interventions is gauged by comparing pre- and post- training AB to salient cues. Pre/post training bias was assessed with a "standard" visual probe task that directed attention

equally to neutral and salient cues. The modified task trains attention to focus on a single type of stimuli by always replacing either the neutral (attend-neutral) or salient (attend-food) visual cues with a probe to which the participant must respond. A stimuli-matched standard visual probe task is used for the no-AR condition as a substitute for training. AR has been employed in a number of settings and with various populations. This study was the first to examine the effect of an AR intervention on acute food intake in any population. The purpose was to train attention away from unhealthy food cues and toward healthy food cues.

**Clinical Utility of Attentional Retraining**

**Anxiety Disorders**

AR was first studied in the anxiety disorders, and has been shown to impact AB post-training among individuals trained to attend to neutral words and among a negative word-trained group (154). Mathews & MacLeod's cardinal study (154) on AR also demonstrated that AR affects mood. Self-reported anxiety and depression on an anagram stress task post-AR was significantly lower among participants who completed attend-neutral training compared to participants in attend-negative retraining (154). AR has been applied to pain-related stimuli and successfully modified self-reported responses to a painful task (156).

In addition to being used to reduce anxiety and stimulus perception in the laboratory, AR has successfully been used to teach participants to attend away from threatening stimuli over the internet (131; 150).

Given the success of AR interventions designed to reduce attention to threatening stimuli and decrease anxiety (4-6; 107; 130; 134; 142; 150; 154), AR interventions have

been designed to reduce AB toward drug-related cues, primarily nicotine and alcohol cues.

**Addictions**

Several studies have successfully used AR to shift attention away from (or toward) alcohol stimuli (70; 75; 76; 199; 263-265). Some studies have included post-AR assessments of alcohol consumption, finding that heavy social drinkers consume significantly less alcohol following avoid- than attend-alcohol AR (76). Effects of AR do not, however, generalize in the avoid-alcohol group to reduced AB on different AB tasks or impact alcohol craving (75; 199).

Among smokers, AR interventions have shown utility in the reduction of AB yet have yielded little support for the generalization of effects to novel stimuli not used in the AR task and little support for reduction in craving (9; 79; 157).

**Eating Disorders**

Eating disordered patients show an AB for food-, body shape-, and weight-related cues (for review see 206). Previous research using the modified Stroop paradigm (58), the visual probe paradigm (188; 204), and the visual search paradigm (209) have indicated the existence of AB for body- and food-related information in eating disorder patients.

Smeets et al. (207) tested whether body satisfaction is influenced by AB for one's own body parts. Healthy undergraduate women who were trained to attend to body parts they had self-identified as unattractive showed a reduction in body satisfaction post-training. Interestingly, the comparison group of female students who were slightly body-dissatisfied was trained to attend to self-identified attractive body parts and reported an

increase in body satisfaction post-training (207). It is very important to determine the utility of AR to modify eating behavior among body-dissatisfied women to determine the clinical utility of AR in weight management interventions.

Another retraining study was conducted in 2010 (117), and focused on the relationship between inhibitory control and high calorie food consumption. Among self-reported chocolate cravers, training to inhibit responses to chocolate stimuli resulted in significantly reduced chocolate intake. These findings suggest that one strategy to help regain control over food intake may be increasing inhibitory control. It is possible that the success of Houben & Jansen's AR intervention could be applied to other foods that are high in sugar and fat, such as those used in the present study. The AR paradigm that was employed in the present study was performed by participants in a satiated state. AR may help restrict AB to food cues during appropriate times, such as when physiologically hungry.

***Summary***

Studies have used AR to reduce anxiety, modify AB to smoking and alcohol cues, and reduce substance use. AR has also been employed in nonclinical female samples and modified body consciousness and self-esteem. This study was the first to test the ability of AR to modify AB, craving, and food intake among a nonclinical sample of healthy weight and obese women.

The aim of the current study was to replicate and extend previous research by evaluating the impact of a single session AR intervention that directs attention away from unhealthy food cues. This study differs from previous studies in the addictions in that the focus of AR is not only away from unhealthy food cues but toward healthy (vs. neutral)

cues. This is also the first AR study conducted among obese women using a modified visual probe task and a matched control no-training task. The use of a control condition allows for isolation of the effect of the AR designed to reduce AB to unhealthy food cues. In addition, this study differs from previous AR studies in the evaluation of craving and inclusion of a taste test to measure the difference in eating behavior between training conditions that parallels findings from single session AR studies of smoking and alcohol.

# CHAPTER 2: RATIONALE AND SPECIFIC AIMS

## RATIONALE

Treatments for both addictive behavior and obesity are largely unsuccessful. AB for salient cues interferes with treating both addictions and obesity. AB elicits craving and predicts relapse and weight gain (43), undermining treatment effects. Cognitive retraining strategies that interfere with implicit cognitive processes, such as AB, have been successfully employed in the addictions and show promise as a means of reducing AB among obese women. Such strategies may also play an important role in preventing weight gain among healthy weight individuals, thereby counteracting the growing rates of obesity (135).

Partially contributing to the high rates of obesity, obese women have a heightened AB for high-calorie food cues that is far greater than that of healthy weight women (45; 170; 258). AB has also been related to increased craving and energy intake among obese women. Although interventions have successfully modified AB to smoking and alcohol-related cues (9; 77), no studies have tested strategies to reduce AB to salient food cues among obese women. Further, the impact of reducing AB with AR on food craving and acute energy intake is unknown.

## SPECIFIC AIMS

Increasingly, in an effort to understand the dramatically increased rates of obesity, researchers are conceptualizing AB for highly-palatable food among obese individuals as a manifestation of neurobiological deficits that promote overeating in response to

environmental cues (rather than hunger). The same neurobiological deficits that are present after repeated drug use facilitate heightened attentional responses to food cues (when satiated) among obese individuals (25; 51; 234; 237; 241).

Given the neurobiological similarities between addiction and obesity, the model used in the current investigation (**Figure 1**) was derived from Franken's 2003 neurocognitive model of addiction with the addition of AR as a means of reducing AB. Franken's model proposes that when a drug cue elicits attention it is difficult to draw attention away, and subsequently enhanced attention (e.g., AB) results in drug craving and may also trigger drug use/relapse. Via similar neurobiological mechanisms, obese individuals show heightened AB for palatable food when satiated that causes craving and increases the risk of overeating (23; 84). High-calorie food cues are more salient to obese individuals demonstrated by greater AB compared to healthy weight women (45; 169; 170; 258).

The model in the current study used Franken's model of addiction to explain AB, craving, and overeating in satiated obese women. The overarching goal of this study was to use Franken's model to examine the utility of AR in decreasing food intake among obese women. AR is an area that may have particular utility in obesity, both treatment and prevention, given its success in reducing AB to salient cues in addiction.

A series of three aims address the relationship between weight status and AB (Aim 1), the preliminary utility of AR to reduce food intake (Aim 2), and the role of craving as a partial mediator of the relationship between AR and food intake (Aim 3). The hypotheses of this investigation were based on the model presented in **Figure 1**. Generally, it was hypothesized that obese individuals would display an enhanced AB to

food-related stimuli as compared to healthy weight individuals (45; 170; 258), and in particular palatable stimuli (179). An enhanced drive to eat was expected in satiated obese, but not healthy weight, individuals. Since an enhanced AB to food cues when satiated among obese compared to healthy weight persons has been previously reported, the focus of the hypotheses was on obese participants.

The AR strategy used in this study was a single session and was intended to interfere with automatic attention to unhealthy cues by redirecting attention toward healthy cues. Retraining smokers and nonsmokers to attend away from smoking cues reduced AB to smoking cues more among smokers than nonsmokers following a single training session (9). Attending toward alcohol cues during a single session of AR increased alcohol intake more than attending away from alcohol cues (76), though single session AR interventions have not resulted in substantial modifications to explicit reports of cigarette or alcohol craving (9; 199). The single session food-cue AR intervention in the present research was expected to affect AB of obese women more than healthy weight women.

Franken's model of addiction posits craving as a mediator of the relationship between AB and intake. Food cravings are presumed by Franken (2003) to be activated by attention to salient cues or in response to an internal or external cue. Through food cravings, the motivation to eat intensifies and the risk of overeating high-calorie foods grows. Simply activating AB to salient food cues is not posited to elevate motivation to eat enough to cause a relapse to overeating because AB is an implicit process and food cravings are recognized by one's conscious awareness. Reducing AB should therefore affect food intake, making AB a partial mediator of food intake. In the adapted model of

Franken's used in the present research, craving is also conceptualized as a partial mediator of food intake. However, craving may not change as the result of a one session retraining such as in this study. Over time, however, retraining is expected to decrease self-reported food cravings and food intake. Consequently, a long-term goal of this work is to develop AR-based interventions that may offer potential benefit in the prevention and treatment of overweight/obesity.

## General Analytic Strategy

Baseline (e.g., pre-experimental) differences between weight groups and attention conditions with respect to demographic variables (age, BMI) and questionnaire scores (EI, YFAS, EAH) were assessed by means of separate univariate ANOVAs.

Univariate ANCOVAs examined pre-training differences in AB between weight groups and attention conditions. Ethnicity was included as a covariate.

To examine differences in AB from pre to post-training between weight groups and training conditions, 2 (cue: food vs. neutral; unhealthy food vs. healthy food) × 2 (attention condition) × 2 (weight group) repeated measures ANCOVAs were conducted. Condition and weight group were between subjects factors and cue was the within-subjects factor. Ethnicity was included as a covariate.

Food intake was analyzed by univariate ANOVA. Significant interaction effects were followed up with Bonferroni-corrected *t*-tests.

## Hypotheses and Statistical Analyses

### Aim 1

To examine pre-training differences in AB and food cravings between satiated healthy weight and obese women. Obese individuals were expected to evidence a more positive AB to 1) food cues (relative to nonfood cues) and 2) unhealthy food cues (relative to healthy food cues) compared to healthy weight women. Moreover, elevated levels of self-reported food cravings on the Food Craving Inventory were hypothesized among obese women. Associations between cravings and AB to food cues were expected among obese participants.

***Hypothesis 1a.***

AB to food cues, particularly unhealthy food cues, was hypothesized to be positive among obese but not healthy weight women.

***Hypothesis 1b.***

Correlations were expected between food cravings and positive AB to unhealthy food cues.

### Aim 2

The second aim of this study was to reapply Franken's model of addiction to examine the impact of AR on AB and food intake among obese women. Specifically, to determine whether a single session of AR (vs. a no-AR control condition) reduces AB to unhealthy food cues and reduces post-training food intake among obese women.

***Hypothesis 2a.***

A single session of AR, in comparison to a control condition, was expected to reduce AB to unhealthy food cues.

***Hypothesis 2b.***

A single session of AR, in comparison to a control condition, was expected to reduce acute post-training taste test food intake.

**Aim 3**

To examine whether craving changes in a short term AR paradigm and whether craving and/or AB mediate the relationship between AR and food intake.

It was hypothesized that there would be a relation between type of training (AR or control) and food intake and this effect would be partially mediated by AB to unhealthy food cues (a proximal mediator) and mediated partly through food craving (distal mediator) (**Figure 2**).

***Hypothesis 3a.***

It was hypothesized that there would be a relation between type of training (AR or no-AR) and food intake and this effect would be partially mediated by food craving.

***Hypothesis 3b.***

It was hypothesized that the relation between type of training (AR or no-AR) and food intake would be partially mediated by pre to post-training change in AB to unhealthy food cues.

# CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

## OVERVIEW

Participants completed a two and a half hour single laboratory visit to the Uniformed Services University of the Health Sciences (USUHS) within one hour after consumption of customary lunchtime meal. Intake was verified by self-report logs completed by participants. Logs included time and content of last meal the previous evening and breakfast and lunch on the day of testing (215). Participants completed self-report questionnaires, had anthropometric measures taken, and completed computerized tasks of AB to food cues. Participants were randomized to either an AR or a matched control no-AR condition after which all participants tasted and rated four foods. The design of the study was a 2 (training: AR vs. no-AR) x 2 (time: pre-training vs. post-training) x 2 (group: healthy weight, obese) mixed design. Training session and group were the between subjects factors. Time was the within subjects factor. Dependent variables of interest were AB scores, measures of food craving, hunger, and satiety, and taste test energy intake.

## RECRUITMENT STRATEGY

Participants were recruited using numerous methods. Paper advertisements (Appendix A) were placed in local newspapers in the Washington DC metropolitan area (Washington Post Express, NIH Record, and other newspapers). Fliers (Appendix A) advertising the study were placed in several university (USUHS) and other settings throughout Montgomery County, Prince Georges County, and Baltimore County.

Additionally, advertisements were posted on online bulletin boards across the U.S. (http://www.craigslist.org), and online newsletters (USU Center for Health Disparities Quarterly Newsletter).

### Participant Screening

Interested individuals contacted the PI/study staff via a phone number provided on advertisements, online message boards, and bulletins. Upon calling the phone number, potential participants heard a brief verbal summary of the research study and had the option to leave a voicemail message. PI/study staff contacted interested potential participants and conduct verbal screens over the phone using the screening form (Appendix C).

Prospective participants were phone-screened prior to scheduling a time to come to the university to participate in study procedures. Exclusion criteria were assessed during the screening process. Participants were asked about food allergies and food preferences, and asked questions to verify that health status criteria for inclusion were met. Upon meeting criteria, participants were scheduled for a two-hour appointment beginning within one hour after the participant consumed lunch (215). Participants were asked to eat lunch immediately before coming to the laboratory and asked to consume the amount they usually eat, and record everything they eat on the day of their study visit and the time consumed (breakfast and lunch).

### Inclusion/Exclusion Criteria

All participants were female, BMI $\geq$ 18.5 kg/m$^2$, between the ages of 18 and 60, and had 20/20 vision or corrected vision through eyewear (e.g., contact lenses,

eyeglasses). Participants were required to be in good self-reported physical and mental health, and could not have any food allergies to or dislike of nuts or chocolate. Criteria for exclusion included self-reported diagnosis of diabetes mellitus, thyroid disease, uncontrolled hypertension, current smoking, pregnancy or lactation due to breastfeeding.

Only females were eligible to participate because of gender differences in food craving and eating style that were of interest in the study (36; 41). Visual acuity within normal limits was required for accurate task performance. Additionally, participants were required to have a BMI $\geq$ 18.5 kg/m$^2$ in order to classify participants into healthy weight and obese groups.

Any participant endorsing food allergies or dislike for chocolate or peanuts was excluded from participation because chocolate was provided in the taste test and M&Ms are produced in a factory that also processes products containing tree nuts. Participants who self-reported a diagnosis of diabetes were excluded due to the impact of sugar intake on blood glucose levels during the taste test. Women who were pregnant or lactating were excluded because of changes in eating behaviors associated with pregnancy (21).

Individuals indicating a current diagnosis or undergoing treatment for a mental health problem (e.g., major depression, bipolar disorder, eating disorder, etc.) were excluded from participation as this study was not equipped to provide adequate resources to assist women suffering from severe emotional problems. Further, many medications (such as antidepressant and anti-psychotic medications) impact bodyweight through mechanisms unrelated to lifestyle behaviors (94; 165; 203). Interested participants were queried about current use of prescription and over-the-counter medications/supplements that they were taking in order to exclude based on medications/supplements that affect

body weight and/or eating behavior. Additionally, participants indicating current history of depression on the phone screening or medical history and demographic form (see appendices) were withdrawn from the study and provided referrals for further counseling and treatment.

A full list of inclusion and exclusion criteria is available below:

Inclusion Criteria:

- Adult female between the ages of 18-60 years
- Body mass index (BMI) > 18.5 $kg/m^2$
- No major medical conditions that influence body weight (such as diabetes, thyroid disease)
- Non-smoking

Exclusion criteria:

- Dislike of or allergic to nuts or chocolate/lactose intolerant
- Uncontrolled hypertension
- History of thyroid disease
- Diabetes
- Current tobacco use
- History of anxiety disorder, personality disorder, substance dependence, schizophrenia, eating disorder
- Untreated major depression
- Current use of medications or over-the-counter supplements that affect body weight or eating behavior
- Pregnancy or lactation

## PROCEDURES

Study procedures are outlined in **Figure 3**. Upon arrival, participants were informed of the types of assessments they were asked to complete. They were informed that training group selection was random and that they would be asked to complete a taste test of some foods at the end of the study. Participants then completed the research consent form (Appendix D) and completed study procedures for each of the four study phases: baseline, pre-training, training, and post-training. Participants completed study

procedures individually in a private room. A research team member was available at all times to answer questions.

Participants subsequently completed questionnaires (baseline phase), computer tasks of AB before (pre-training) and after (post-training) AR/control task (training phase), and completed a taste test (post-training).

### Laboratory Consent

The PI/study staff reviewed the informed consent (Appendix D) with each participant. Participants read, signed, and initialed the informed consent form. A witness and the PI reviewed each consent form and signed. Participants were provided a paper copy.

## Study Timeline

The study consisted of four phases: baseline, pre-training, training, and post-training. **Figure 3** outlines study procedures by phase. During each phase, participants completed rating scales of hunger, satiety, desire to eat, and craving (see Appendix F for self-report questionnaires).

### Baseline

The baseline phase lasted approximately 40 minutes. After signing the consent form and having measurements taken, participants completed a battery of self-report questionnaires (see measures section). The self-report battery included a demographic and medical history form, and self-report measures with questions about eating behaviors and food cravings. Visual analog scales (VAS) of likeability (liking, wanting) for 8 foods (4 of which were provided in the taste test) were completed at the end of the baseline

period. VAS for hunger, satiety, desire to eat, and craving were also completed (VAS BL).

**Pre-training**

The pre-training phase lasted approximately 15 minutes. All participants completed a standard visual probe task of AB during pre-training. Visual probe task stimuli included neutral, healthy, and unhealthy food cues. The standard visual probe task was completed again during post-training.

**Training**

The training phase lasted approximately 30 minutes. During the training phase a 22-minute visual probe task separated into 4 blocks was administered. Participants were given breaks between blocks as needed. VAS (hunger, satiety, desire to eat, craving) were completed immediately before block 1 (VAS-ARpre) and immediately after completion of block 4 (VAS-ARpost). Task stimuli during training included novel pairs of healthy and unhealthy foods not presented during pre-training. Participants randomized to the AR condition completed a modified version of the visual probe task in which the probe replaced the location of healthy food pictures on 100% of test trials (attend-healthy). Participants randomized to the no-AR condition completed a matched control visual probe task in which the probe replaced unhealthy food pictures and healthy food pictures with equal probability (no training of attention).

**Post-Training**

The final phase of the study required 35 minutes (15 minutes visual probe task, 20 minutes taste test). Following training, participants completed the standard visual probe task completed during pre-training.

**Taste Test**

After completion of the computer task, participants completed a VAS of hunger, satiety, desire to eat, and craving (VAS-TTpre) before beginning the taste test. Participants had 15 minutes to taste test four foods and complete VAS of liking, wanting, palatability, taste, and smell for each food. Foods used for the taste test, caloric content, and testing procedures were adapted from previous work with healthy weight and obese women who participated in food-related cue-reactivity tests prior to a taste test (170; 258).

Participants were provided 4 identical pre-weighed bowls, two of which were high-calorie snack foods: ± 450 g of milk chocolate M&Ms (532 kcal/100 g), ± 140 g of original salted potato chips (549 kcal/100 g), and two of which were lower-calorie choices ± 450 g of baby carrots (35 kcal/100 g), ± 140 g of oil-popped popcorn (300 kcal/100 g). The order of the bowls was random.

In front of each food bowl, participants had a VAS containing questions about the likeability of the respective food. The participants were left alone for 15 minutes with instructions to taste the foods carefully, one by one, as many times as desired and to fully rate each food using the questionnaires provided. They were told to eat as much as they liked. VAS of hunger, satiety, desire to eat, and craving were completed one final time after the taste test (VAS-TTpost).

Participants were not told that their taste test food intake would be measured, and that food intake (in kcal) would be calculated. This information was disclosed during the debriefing at the end of the study.

## Debriefing

After the study procedures were completed, participants were provided a list of physical and mental health resources and information about the true nature of the study (Appendix B). The researcher reviewed the nature of the study with each participant and answered questions about the study procedures, the subject of the study, or the materials provided.

## Less Than Full Disclosure

In general, the exact purposes and research questions of the study were concealed from the participants until the conclusion of the study when participants were debriefed (Appendix G). Individuals were fully debriefed at the end of the experiment and asked whether they had awareness about the true purpose of the study. Participants were initially told that the study concerned the impact of appetite on attention and task performance. IRB approval was obtained, as less than full disclosure was necessary because if participants are aware that the study was evaluating responses to food-related cues, they may inadvertently change their behavior on computerized tasks and/or answers to self-report measures.

Participants were not told that their food intake during the taste test would be measured. The purpose of the taste test was to evaluate training group differences in cue-elicited food intake. Food intake during the taste test could be biased if participants were aware that their intake would be measured.

## MEASURES

### Anthropometric Indices

Height, weight, waist circumference, hip circumference, and body fat were measured during baseline (Appendix E). Participants were asked to remove shoes and coats to acquire weight and height in order to verify their self-reported BMIs to ensure eligibility for study inclusion ($\geq$ 18.5 kg/m$^2$). Body composition was measured with a Tanita BF-350 Body Composition Analyzer Scale. Height was measured in inches using a ruler affixed to a wall. BMI (kg/m$^2$) was calculated from weight and height measurements. A cloth tape measure with a spring-loaded handle was used to measure waist and hip circumference using published guidelines (2).

### Self-Report Questionnaires

Self-report questionnaires were administered to participants to evaluate aspects of eating behavior relevant to study analyses. All questionnaires were completed once at baseline, unless otherwise specified.

*Assessment of eating style*

AB for food cues has been related to dietary restraint (101; 172; 180), and external eating (39; 126; 169) in healthy weight and obese individuals. For this reason, eating style was assessed to examine correlations between attentional bias scores and eating styles in AR and no-AR groups.

The Eating Inventory (EI) (223) measures three psychological predictors of eating behavior: cognitive restraint of eating, disinhibition of control, and perceived hunger awareness. Each subscale of the EI measures a conceptually independent feature of eating behavior and the three subscales were analyzed separately according to published

guidelines (223). This 51 item questionnaire consists of 36 true/false and 15 Likert scale (4 point) items. The EI has high internal consistency (Cronbach's alpha = 0.79–0.93) among samples of dieters, free eaters and dieters and free eaters for all three subscales (223). The EI has been used in studies of obesity, eating disorders, and weight-related behaviors and has shown increased disinhibition and susceptibility to hunger in obese, relative to healthy weight, individuals (115; 144). The EI has also been used in AB research with healthy weight and obese female undergraduates (45). Higher scores denote greater eating pathology.

The Eating in the Absence of Hunger – Eating Past Satiation Scale (EAH) (225) is a 14-item measure rated on a 5-point Likert scale designed to assess the extent to which a person eats when they are not hungry. The EAH includes questions related to eating in response to sensory and social cues, eating in response to emotions, and when EAH occurs (e.g., home, restaurant). Subscales of perceived eating in the absence of hunger in response to external cues, negative affect, and fatigue or boredom are scored by summing the items loading on each scale. Eating in the absence of hunger refers to eating in response to the presence of palatable foods even when perceived internal hunger cues are not present (133). EAH is a stable trait (28; 80) that increases with age (28). The EAH includes questions related to eating in response to sensory and social cues, eating in response to emotions, and when EAH occurs (e.g., home, restaurant). Answers range from "Never" (= 1) through "Always," (= 5) for all 14 questions. Subscales of perceived eating in the absence of hunger in response to external cues, negative affect, and fatigue or boredom were scored by summing the items loading on each scale. The EAH was created for use with 6-19 year old youth (225) and has high

internal consistency in this population. The EAH has been adapted by Tanofsky-Kraff and colleagues for use with adults (Tanofsky-Kraff, in progress).

*Assessment of mood and psychological symptoms.*

The Eating Disorder Diagnostic Scale (EDDS) (218) is a 22-item scale that is useful as a screening tool for anorexia nervosa, bulimia nervosa, and binge eating disorder. The EDDS was used to evaluate eating disorder symptoms in participants without administering a clinical interview. There is a high rate of agreement between eating disorder diagnoses from clinical interview and those from the EDDS, with 99% for anorexia, 96% for bulimia, and 93% for binge eating disorder. There is also evidence of internal consistency across items (alpha = .89) (218). To rule out participants with anorexia nervosa, the Eating Disorders Diagnostic Scale (EDDS) (217) was administered to each participant at baseline. Past or present eating disorder diagnosis was included in the screening questionnaire

*Assessment of food craving*

The Yale Food Addiction Scale (YFAS) (90; 91) is a 25-item assessment tool developed to quantitatively measure food addiction by identifying eating behavior patterns characteristic of dependence (e.g., tolerance, withdrawal, loss of control). The YFAS has good convergent and incremental validity and internal consistency ($\alpha = .86$). The YFAS provides two options for scoring. The YFAS can be scored by counting the number of symptoms or with a diagnostic version. To receive a "diagnosis" of food addiction, an individual must report experiencing 3 or more symptoms in the past year and endorse clinically significant impairment or distress. The version of the YFAS used in the present study measured all items using a Likert scale as done in previous research

(91; 92). According to YFAS scoring instructions, 5 of the Likert scale items are dichotomized, and participants receive a score of 0 or 1 based on whether they have experienced the indicated symptom in the past year or not. YFAS scores are correlated with activity in areas of the brain involved in addictive behavior (92).

The Food Craving Inventory (FCI) (261) measures cravings for four categories of foods: High Fats, Sweets, Carbohydrates/Starches, and Fast Food Fats. The FCI defines craving according to the criterion set forth by Kozlowski and Wilkinson (132) asserting that each food in question be intensely desired. The FCI has been validated in participants recruited from university and community settings. The FCI has adequate total scale (Cronbach's alpha > 0.86) and subscale reliability (Cronbach's alpha > 0.70).

*Other measures*

Several scales were created to measure participant's perception of task stimuli, taste test foods, and other factors that are related to outcome variables. Visual Analog Scales (VASs) were selected for the majority of testing because they enable fast measurements whereas multi-item questionnaires are time-consuming and can be sensitive to social desirability (74; 124; 221). The VAS has been validated for assessment of appetite (83) and used previously in studies of AB among obese individuals (170; 258)

Visual Analog Scales (VAS). As an index of subjective level of hunger, satiety, desire to eat, and craving, a series of 100mm VAS ranging from ''not at all'' to ''extremely'' were completed by participants 5 times in total during the study. VAS measuring ''hunger,'' ''fullness,'' "desire to eat," and "craving" (Appendix F) were completed at baseline, before and after training, and before and after the taste test (see **Figure 3** for the time course of the experiment). Baseline hunger ratings were particularly

important, as all participants were asked to eat lunch no more than one hour prior to arriving for their study appointment so they were full when they began the study.

VAS of ''liking," and "wanting" for each food in the taste test were completed at baseline, and VAS of "liking," "wanting," and several measures of ''taste'' were completed during the taste test for each of the for the 4 snack foods. The scales ranged from ''not at all'' to ''extremely'' on a 100-mm line. VAS questions were based on previous AB research in healthy weight and obese females (170; 258).

VAS rating scales for each picture presented during the dot probe tasks (pre-training, training, and post-training) were provided to participants at the end of the study to assess pleasantness of the images. Participants viewed each image individually and scored each picture on a VAS scale for valence (0 = very unpleasant; 100 = very pleasant) (169).

**Computer Assessments**

All tasks were administered on an IBM compatible Pentium III computer running EPrime experimental presentation software (Psychology Software Tools, Inc.), which measures reaction time (RT) in milliseconds. The visual probe tasks were designed to model previous studies assessing AB in obesity (45; 170).

Participants completed a standard visual probe task during the pre-training and post-training phases. The same set of pictures was used for the pre-training visual probe task but post-training visual probe stimuli were modified to assess generalizability of AR to novel stimuli. Details of task stimuli are provided below.

*Visual probe task*

Participants performed a standard visual probe task to measure pre-training and post-training bias to food-related visual stimuli. A modified visual probe task with different parameters and stimuli was administered to participants in the no-AR condition and adapted for administration to participants in the AR condition.

*Standard Visual Probe (Pre-training/Post-training)*

A standard dot probe task adapted from previous AB research with obese women (170; 258) was administered before and after training. Participants were required to identify the location of a probe (black circle) that replaced one of two pictures on the computer screen. Pre-training and post-training standard probe tasks consisted of 120 trials. Each trial began with a fixation cross (+) in the center of the screen for 500ms, followed by the appearance of a pair of critical (80 total: food/neutral (40 trials), unhealthy food/healthy food (40 trials)) or filler (40 total: neutral/neutral) trial pictures displayed side by side. The pictures remained on the screen for 500ms. After the pictures disappear from the screen, a probe appeared in the place of one of the two pictures. The participant responded as quickly as possible to the location of the probe by pressing a button to select the left or right picture using the computer keyboard. The probe disappeared once a response was detected. The intertrial interval (the amount of time between disappearance of the visual probe and appearance of the fixation cross for the next trial) was 500ms.

Pre and post-training food:neutral and neutral:neutral image pairs of stimuli were selected from color pictures borrowed with permission from Castellanos (45). One half of the critical pairs used in pre-training (food/neutral; unhealthy food/healthy food) were

presented in the post-training task to enable pre and post-training comparisons. The remaining post-training trials were comprised of novel picture pairs and images presented during the training task to assess generalizability of the AR effect to novel stimuli.

In summary, post-training stimuli included images used during AR images from pre-training, and novel images. Selection of food and neutral pictures was based upon valence and arousal ratings from pilot testing.

*Modified Visual Probe (attentional retraining)*

The modified probe task used during training consisted of unhealthy food: healthy food pairs only. Participants who were assigned to the AR condition performed a modified visual probe task consisting of 800 trials, separated into four blocks of 200 trials each. The number of trials was based on AR research in smokers in which 768 trials (512 training, 256 test trials evenly split pre and post) modified craving in males but not females (9) and research in social drinkers in which craving in the attend-alcohol condition increased across 896 training trials (76). No AR research in the eating literature has evaluated craving and all studies used fewer than 400 training trials (64; 208; 210). Therefore the number of trials and task parameters selected for AR was based on previous single session AR research that measured (and reported change in) craving for cigarettes (9) and alcohol (76).

Each trial commenced with a fixation point in the center of the screen for 500ms followed by an unhealthy/healthy food picture pair. Food pictures included images of high-calorie foods that contain large quantities of fat and/or sugar (e.g., cheesecake, soda) and low-calorie nutrient rich foods (e.g., fresh fruit, salad, grilled chicken, salmon, water). All images were novel, and had not been used during the pre-training standard

probe task. Images remained on the screen for 500ms and the probe replaced the healthy figure on 100% of the trials. After a response was logged the next trial immediately began. Healthy (10 pictures) and unhealthy pictures (10 pictures) were used with permission from Castellanos (45) and modified using non-copyrighted images as necessary.

*Standard Visual Probe (No-training control condition)*

Participants who were assigned to the no-AR condition performed 800 trials of the visual probe task used in the AR condition, except that the probe replaced the unhealthy food picture on 50% of trials and replaced the healthy food picture on the other 50% of trials.

**Visual Probe Data Preparation**

Data from trials with incorrect responses, RTs < 200 ms, or > 1500 ms, or more than 3 SDs above each participant's mean were excluded (45; 71; 162; 170). Data from error trials were excluded (2.9% of data pre-training, 3.2% post-training). Median latencies in reaction time and AB index scores were used from the VP task pre and post-training for each participant.

Median RT was used as a measure of central tendency in both the food:neutral (probe replacing food picture vs. probe replacing neutral picture) and food:food (probe replacing unhealthy food picture vs. probe replacing healthy food picture) conditions to reduce the influence of reaction time outliers (185). Median discrimination latencies were calculated and used in analyses because the visual probe data were positively skewed (149; 199). Median reaction times were computed from critical trials with correct responses.

AB index scores were computed by subtracting mean RT to food stimuli from the mean RT to neutral stimuli in food:neutral trials, and subtracting mean RT to unhealthy food stimuli from mean RT for healthy food stimuli in food:food trials. Positive bias scores reflect a bias toward food and unhealthy food, respectively. Negative bias scores indicate AB towards neutral and healthy food targets, which can also be considered attentional avoidance of food or unhealthy food respectively.

### POWER ANALYSIS

Previous findings in the AB literature among obese and healthy weight women who were hungry (45; 170) and satiated (45; 170; 258) and single session AR (9; 79) literature were used to estimate effect sizes. A sample size of 80 participants was selected to examine all hypotheses at a power > 80% with Type I error < 0.05, assuming no dropout between pre-training and post-training (e.g., time 1 and time 2). All power analyses were performed with the NQuery Version 7.0. power calculation software package. All analyses were conducted using the Statistical Package for the Social Sciences (SPSS) version 20.0 software package. All statistical tests were two-tailed with $\alpha < .05$ unless otherwise stated. Data are expressed as means ± standard deviation (M, SD).

A sample size of 40 per weight group (healthy weight; obese) was expected to have adequate power to detect an effect size of 0.634 using a two-tailed two group t-test with Type I error set at 5%. The inclusion of ethnicity as a covariate in ANCOVA models explained a substantial proportion of the variance in the dependent variables, reducing actual minimum effect size to -0.33.

A 2 (group: healthy weight, obese) x 2 (Training; AR, no-AR) between-subjects ANOVA had 80% power to detect a significant interaction when the sample size was 20/group (total N=80) assuming a 5%, 2-sided significance level.

Cohen's *d* was used to estimate effect sizes. Cohen's *d* calculates effect size between two sample means by dividing the difference in means by the pooled standard deviation. Using Cohen's *d* is appropriate when sample sizes are unequal, as there is no influence on the denominator in this equation.

For SEM analyses, a sample size of more than 500 participants was needed to detect an effect size >.5 with 80% power. SEM analyses were underpowered to produce a significant effect at the collected sample size of N=80.

# CHAPTER 4: RESULTS

## DEMOGRAPHICS AND BASELINE MEASURES

In response to internet and posted advertisements (Appendix A), 204 women were screened for participation in a single-session research study on appetite and attention. Of the women who inquired about the study, 128 were eligible and 80 completed the study. Reasons for exclusion included: BMI below 18.5 $kg/m^2$, age outside the approved range (18 - 60 years), presence of physical and/or mental health conditions (e.g., diabetes, thyroid disease, depression), and tobacco use. Civilian participants (n=78) were paid $50. Active duty participants (n=2) were not financially compensated.

Data from one participant was excluded from analyses due to failure to accurately complete the post-training visual probe task. Accuracy rate post-training was 56.8%, which is below the allowable threshold. The final sample consisted of 79 women of which 43 were healthy weight or moderately overweight (BMI $< 27.0$ $kg/m^2$) and 36 were obese (BMI $\geq 30.0$ $kg/m^2$). All analyses were conducted with the remaining 79 participants unless otherwise indicated.

### Demographics

Demographics for the entire sample and separated by weight group are presented in **Table 1.** Participants averaged 33 years old (SD = 11.8). The women had a mean weight of 172 pounds (SD = 49.7) and mean BMI of 28.6 $kg/m^2$ (SD = 8.3). The majority of participants were single (56%) or married (27%) and almost half had completed college (44%) or some/all graduate school (29%). Nearly half of the participants (49%) were Caucasian, 35% African American, 3% Hispanic, 10% Asian and 3% other. Sixty-

three percent were employed full time and nearly a quarter of the sample (23%) was unemployed when they completed the study.

**Psychological measures**

***Eating Disorders Diagnostic Scale (EDDS)***

Eating disorder diagnoses by weight group are provided in **Table 2**. The Eating Disorders Diagnostic Scale (EDDS) (217) was administered to rule out participants with anorexia nervosa (bulimia and binge eating disorder were not excluded) since the intention of retraining was to reduce food intake. According to the EDDS, the majority of women (77%, n = 61) did not meet criteria for an eating disorder. No participants met criteria for anorexia nervosa (full or sub-threshold) and the remaining 23% of participants met at least subthreshold diagnostic criteria for bulimia nervosa or binge eating disorder. Examination of EDDS results by weight group revealed no significant differences between groups ($\chi^2$ (4) = 4.469, $p$ = 0.346).

**Food craving measures**

***Yale Food Addiction Scale (YFAS)***

To identify patterns of eating behavior that are characteristic of dependence among the participants, the Yale Food Addiction Scale (YFAS) (90; 91) was administered (**Table 3**). Overall, participants reported few symptoms of dependence and 4% (n=3) of the sample met diagnostic criteria for food addiction, binge eating above and beyond what is predicted by other measures. This is lower than the 11.4% of coed undergraduates who met criteria for substance dependence in a previous study (91).

The sample scored a mean of 2.04 ($SD$ = 1.47) symptoms of dependence out of a possible 7 total score. Total symptom counts were significantly higher among obese

women than healthy weight women ($p = 0.001$). Overall, 54% (n=43) of the sample had 2 or more symptoms of dependence and 8% (n=6) met no criteria for dependence. Participants with higher total YFAS symptoms also had higher: disinhibition and perceived hunger scores on the EI and higher scores on all subscales of the FCI and EAH scales.

***Food Craving Inventory (FCI)***

**Table 3** depicts self-reported FCI subscale and total scores of the sample, by weight group. The Food Craving Inventory (FCI) (261) was used to measure cravings for specific types of foods in four categories: High Fats, Sweets, Carbohydrates/Starches, and Fast Food Fats.

Total FCI scores averaged 2.36 (SD = 0.60) out of a total possible score of 5and total score did not differ between weight groups ($p = 0.267$) (see **Table 3**). Obese women reported more cravings for high fat foods on the fat foods subscale of the FCI than healthy weight women ($p = 0.016$) similar to previous studies from obese samples (261). Women in both weight groups reported craving fast food and sweet food more often than high fat or carbohydrate/starch foods, also similar to previous reports (261).

**Eating style measures**

Self-reported eating behavior scores on the EI and EAH for both weight groups are provided in **Table 3**. Eating style was assessed with the Eating Inventory (EI) (223) and Eating in the Absence of Hunger – Eating Past Satiation Scale (EAH) (225) scales.

***Eating Inventory (EI)***

The EI measures three distinct aspects of eating behavior: dietary restraint, disinhibition of control over eating, and perceived hunger. Mean scores on the three

subscales were: Restraint 9.85 (SD = 5.09), Disinhibition 7.18 (SD = 3.57), and Hunger 5.34 (SD = 3.20).

Because dietary restraint and disinhibition of control are considered markers of dysfunctional eating patterns, differences in eating style between weight groups were expected. Obese women reported more disinhibition of control over eating ($p = 0.001$) than healthy weight women.

Disinhibition was also correlated with total kcals consumed during the taste test, all subscales of the EAH, and the FCI high fat and sweet subscales. Elevated disinhibition meant higher scores on all these measures. Perceived Hunger was not correlated with BMI but was positively correlated with all subscales of the FCI and EAH, and total kcal intake.

***Eating in the Absence of Hunger – Eating Past Satiation Scale (EAH)***

Eating in the absence of hunger was relatively minimal in the present sample in response to negative affect (M = 1.67, SD = .81), external cues (M = 2.77, SD = .81), and fatigue (M = 1.82, SD = .66). Subscale scores were compared between obese and healthy weight women. Obese women reported higher levels of eating in response to negative affect than healthy weight women ($p = 0.032$) but there were no differences between reported eating in response to external cues or eating in response to fatigue between weight groups.

**Ethnicity**

The present sample was highly diverse, so ethnic differences in psychological measures and demographics were examined. The ethnic makeup of the healthy weight and obese groups was significantly different ($\chi^2(5) = 14.84$, $p = 0.011$). Caucasians were

then compared to two other groups; one comprised of African Americans and the second comprised of the remaining categories ($\chi^2(2) = 9.13$, $p = 0.010$). Because of low numbers of Hispanic, Asian, and "other" ethnicity participants, these groups were collapsed into a single 'other' group with African Americans and there remained a significant difference in ethnic makeup between weight groups ($\chi^2(1) = 6.80$, $p = 0.009$). More of the healthy weight women were Caucasian and a higher proportion of the obese group consisted of self-reported ethnic minorities.

Dummy variables were created for ethnicity using the following transformation: Caucasian was coded as 1, all else was coded as 0. The rationale for this was that half the sample fell into each dummy group, with 50% of the sample self-reported as Caucasian and the remaining 50% split unevenly into various other ethnic categories.

There were significant differences between African American/other and Caucasian groups on the high fat subscale of the FCI, and the negative affect subscale of the EAH, which can be seen in **Table 4**. African American women reported higher craving for high fat foods than Caucasian women ($p = 0.001$) but lower eating in response to negative affect ($p = 0.013$).

**Baseline Food Ratings**

To assess food preferences and determine if women eat the types of foods they report liking, baseline ratings of liking and wanting and image pleasantness were acquired for several foods, including those provided in the taste test (Appendix F). Obese women reported wanting ($p = 0.014$) to eat carrots significantly less than healthy weight women in response to images viewed at baseline. Between attention groups, women

randomly assigned to the no-AR group reported wanting ($p = 0.016$) M&Ms more than the AR group and rated the image of the M&Ms as more pleasant ($p = 0.050$).

**Visual Analog Scales**

Baseline (VAS-BL) ratings of participants were compared by means of analysis of variance (ANOVA) to check for differences at study outset between weight and attention groups. VAS scores were entered separately in each model as the dependent variable and weight group (obese vs. healthy weight) and attention condition (AR vs. no-AR) were entered as between-subjects factors.

There were no significant differences in baseline ratings of hunger, fullness, desire to eat, or food craving between weight groups (all $p$'s > 0.172 or attention conditions (all $p$'s > 0.394) and no significant weight group × training condition interaction $F(1,75) = .120\text{-}.893$, $p's > 0.348$. Lack of differences between groups implies that all participants complied with study instructions to eat to satiety prior to testing.

Sets of mean VAS ratings were compared between weight groups and conditions across the training and across the taste test. A 2 (weight group) × 2 (attention condition) × 2 (time) repeated measures ANOVA was conducted with weight group and attention condition as between-subjects factors and time (VAS pre, VAS post) as the within-subjects factor. Separate models were run with VAS ratings of hunger, fullness, desire to eat, and food craving as dependent variables. Separate models were analyzed for training and the taste test. All repeated measures ANOVAs were carried out with Greenhouse–Geisser dfs (uncorrected dfs are reported).

There was a main effect of time between VAS-ARpre : VAS-ARpost scores and VAS-TTpre : VAS-TTpost scores for hunger, fullness, and desire to eat. All $p$'s ranged

from .001-.027, indicating that subjective ratings changed significantly from pre and post AR and from pre and post taste test among women of both weight groups and attention conditions. Change in craving changed significantly from VAS-ARpre : VAS-AR post among all groups ($p < 0.001$) but there was no effect pre to post taste test ($p = 0.958$).

## Aims and Hypotheses Results

### Aim 1

The first aim of this study was to examine baseline differences in AB for food cues between satiated healthy weight and obese women.

***Hypothesis1a.***

It was hypothesized that AB to food cues, particularly unhealthy food cues, would be positive among obese but not healthy weight women.

As a reminder, AB index scores were calculated by subtracting the reaction times to identify 1) probes that replace neutral stimuli from reaction times to identify food stimuli in food: neutral trials and 2) probes that replace healthy food stimuli from reaction times to identify unhealthy food stimuli in food:food trials (39; 160; 200). Positive AB index scores represent a bias in attention toward food in food:neutral trials and a bias toward unhealthy food in food:food trials. Negative AB index scores represent a bias in attention toward neutral cues in food:neutral trials and a bias toward healthy food in food:food trials (and biases *away from* food/unhealthy food cues respectively) (200).

**Statistical analysis:** To examine pre-training differences in AB between weight groups, group median of participant-level mean RT scores and AB scores for food:neutral and unhealthy:healthy trials were analyzed separately by univariate analyses of

covariance (ANCOVA). A total of four repeated measures ANCOVAs were conducted, each with one within-subjects factor (Cue, 2 levels), and one between-subjects factor (Weight group, 2 levels). Dependent variables were AB index scores for food:neutral and food:food trials.

Each dependent variable was tested in a separate model. Two of the models used food:neutral trials and differed by dependent variable. Two models used unhealthy:healthy trial pairs and differed by dependent variable. Ethnicity significantly differed between weight groups and was included in all models as a covariate. Ethnicity was dummy-coded first.

*Reaction Time Bias*

*a. Food vs Neutral Cues*

In contrast to the hypothesis, there was no significant weight group x cue interaction, $F(1, 76) = 0.217$, $p = 0.643$. Healthy weight participants were faster in general, $F(1, 76) = 9.843$, $p = 0.002$, but there was no effect for cue type ($F(1, 76) = 1.138$, $p = 0.289$) indicating that response time to probes replacing food (HW: M = 430.83, SD = 60.65; OB: M = 496.49, SD = 121.46) and neutral cues (HW: M = 434.22, SD = 62.28; OB: M = 493.81, SD = 108.23) did not differ between weight groups.

*b. Healthy vs. Unhealthy Food Cues*

There was no significant cue x weight group interaction ($F(1, 76) = 3.214$, $p = 0.077$), indicating no difference in RT toward healthy or unhealthy food images among either weight group. Healthy weight women were significantly faster overall, ($F(1, 76) = 9.144$, $p = 0.003$), responding an average of 57.8ms faster across trials than their obese counterparts. A significant main effect of weight group was present such that healthy

weight women responded faster to probes replacing healthy (M = 423.71, SD = 63.42) and unhealthy (M = 437.02, SD = 60.97) targets ($F(1, 76) = 6.870$, $p = 0.003$) than obese women (Healthy: M = 486.25, SD = 108.17; Unhealthy: M = 490.11, SD = 113.17). There was no effect of cue type in either weight group $F(1, 76) = 0.541$, $p = 0.464$).

*Attentional Bias Scores*

*a. Food vs Neutral Cues*

Pre-training AB for food relative to nonfood cues did not significantly differ by weight group ($F(1,74) = 0.209$, $p = 0.649$) or attention condition ($F(1,74) = 0.003$, $p = 0.953$) and no weight x attention interaction was present ($F(1, 74) = 0.002$, $p = 0.961$).

*b. Healthy vs. Unhealthy Food Cues*

AB scores for unhealthy food cues are depicted by weight group and attention condition (**Table 5**) and by attention condition within healthy weight and obese groups (**Table 6**). There was a significant weight group x attention condition interaction in pre-training AB scores for unhealthy food cues ($F(1, 74) = 5.175$, $p = 0.026$) despite random assignment of women in both weight groups to attention condition. There was no main effect of weight group (HW: M = -13.31, SD = 29.10; OB: M = -3.86, SD = 29.41), ($F(1, 74) = 3.672$, $p = 0.059$) and mean AB score for unhealthy food cues among all women in the sample was negative (M = -9.01, SD = 29.44). Follow-up analysis indicated that pre-training AB scores of healthy weight and obese women in the AR condition differed significantly ($F(1,74) = 8.421$, $p = 0.005$). At pre-training, the bias scores of the healthy weight group differed significantly from the zero value ($t(42) = -3.00$, $p = 0.005$) indicative of baseline AB toward healthy food cues, present among healthy weight

women destined to participate in the AR ($t(20) = -2.247$, $p = 0.036$) and no-AR ($t(21) = -2.077$, $p = 0.050$) conditions.

Among obese women, the difference in AB scores between obese women in the AR and obese women in the no-AR condition was significant ($F(1,74) = 5.175$, $p = 0.026$). Obese women assigned to the AR group tended to attend toward unhealthy foods pre-training, with a mean positive AB score (M = 5.61, SD = 27.36). Obese women destined to participate in the no-AR condition had a negative mean bias score toward unhealthy foods pre-training, indicating a tendency to attend away from unhealthy food cues and toward healthy food cues (M = -13.33, SD = 29.01). Obese participants' bias scores did not significantly differ from the zero value at pre-training in the obese group as a whole ($t(35) = -.788$, $p = 0.436$) or among either the AR ($t(17) = 0.870$, $p = 0.396$) or no-AR groups ($t(17) = -1.950$, $p = 0.068$). This indicates that despite a difference in baseline bias scores between the attention conditions and differences, there was no *significant* baseline AB to healthy or unhealthy food cues in either the AR or no-AR condition of the obese group.

***Hypothesis1b.***

Correlations were expected between food cravings and positive AB to unhealthy food cues.

**Statistical analysis:** To examine the association between dietary cravings and AB, a series of correlations were performed between Food Craving Inventory (FCI) subscale scores (i.e., cravings for fats, sweets, carbohydrates, fast food fats) and AB scores.

When analyzing the entire sample pre-training, neither pre-training AB score (M = -9.01, SD = 29.44) nor post-training AB score (M = -4.73, SD = 35.81) for unhealthy food images was positively correlated with BMI, craving scores or any measures of eating behaviors.

**Aim 2**

The second aim of this study was to examine the impact of AR (vs. a no-AR control condition) on AB to unhealthy food cues and acute food intake among obese women.

***Hypothesis 2a.***

A single session of AR, compared to a no-AR control condition, was expected to reduce AB toward unhealthy food cues in obese women.

**Statistical analysis:** To examine the effect of AR on AB for unhealthy food cues, data were analyzed by 2 (Time: pre, post) x 2 (Training: AR, no-AR) x 2 (weight group: healthy weight, obese) repeated measures ANCOVAs. The repeated measures factor was pre and post-training AB score. Between-subjects factors were attention condition and weight group. Ethnicity was included as a covariate in all analyses.

Post-training AB index scores by weight group and attention condition are reported in **Table 5 and Figure 6.** The analysis revealed a three-way time x weight group x attention condition interaction ($F(1, 74) = 3.960$, $p = 0.050$) reflecting a change in AB index scores between pre and post training among obese women who completed AR ($F(1, 74) = 3.960$, $p = 0.050$). AB scores became more negative with training.

Post-training AB index scores did not differ significantly from zero by weight group or attention condition. Further, there was no AB toward either cue type present among obese participants in either the AR ($t(17) = -1.081$, $p = 0.295$) or no-AR ($t(17) = -.009$, $p = 0.993$) condition.

Bonferroni-corrected post-hoc comparisons showed that AB scores of women in the AR condition were significantly different pre-training ($p = 0.005$) between obese (M = 5.61) and healthy weight (M = -17.55) women and between obese women in the AR (M = 5.61) and no-AR (M = -13.33) conditions ($p = 0.037$).

No difference between groups' AB scores was present post-training ($p = 0.340$) as AB scores in all AR participants were below zero (M = -12.97). When attention conditions were split by weight, there were no differences pre to post-training in the no-AR condition in either the healthy weight ($p = 0.210$) or obese ($p = 0.289$) groups. In the AR group, AB scores changed significantly among obese ($p = 0.023$) but not healthy weight ($p = 0.109$) women pre to post-training.

Analysis of weight and attention groups' AB scores did not differ for old pictures by weight group ($F(1, 74) = 0.404$, $p = 0.527$) or attention condition ($F(1, 74) = 0.031$, $p = 0.861$) with no interaction of factors ($F(1, 74) = 0.389$, $p = 0.535$). ANCOVA results on post-test AB scores did not differ for new pictures by weight group ($F(1, 74) = 0.289$, $p = 0.593$) or attention condition ($F(1, 74) = 2.049$, $p = 0.156$) with no interaction effect ($F(1, 74) = 1.168$, $p = 0.283$). Mixed model ANCOVA was conducted using time (pre-training, post-training) as within subjects factor and attention condition (AR, no-AR) as between-subjects factor. Ethnicity was included as a covariate. No significant interaction ($F(1, 76) = 2.229$, $p = 0.140$) or main effects of attention condition ($F(1, 76) = 0.666$, $p = 0.417$) or

time ($F(1, 76) = 0.046$, $p = 0.831$) were present. Mixed model ANCOVA was also conducted using post-training picture type (old, new) as within subjects factor and attention condition (AR, no-AR) as between-subjects factor. Ethnicity was included as a covariate. No significant interaction ($F(1, 76) = 0.959$, $p = 0.331$) or main effects of attention condition ($F(1, 76) = 1.000$, $p = 0.321$) or picture type ($F(1, 76) = 0.393$, $p = 0.533$) were present. Findings indicate that AB generalized to novel food images that had not been presented during AR.

***Hypothesis 2b.***

A single session of AR, in comparison to a no-AR condition, was expected to reduce acute snack food intake during a taste test.

**Statistical analysis:** To examine the effect of AR on food intake during a post-training taste test, data was analyzed by 2 (Training: AR, no-retraining) x 2 (group: healthy weight, obese) univariate ANOVAs with attention condition and weight group as between-subjects factors.

The dependent variables were total caloric intake and intake of each of the four foods provided during the taste test. Significant main and interaction effects were further examined using Bonferroni-corrected post-hoc comparisons. Ethnicity was included as a covariate.

*Taste Test*

Obese women reported that the smell of M&Ms ($t(77) = -2.327$, $p = 0.023$) and potato chips ($t(77) = -2.398$, $p = 0.019$) played a significantly greater role in the amount they wanted to eat compared to healthy weight women. There were no significant

differences between any other hedonic ratings during the taste test between weight groups or attention conditions.

Total food intake during the taste test was 174 kcals **(Figure 7)**, equal to 60g total food **(Figure 8)**. There were no significant main or interaction effects of weight group or attention condition on total intake, intake of potato chips, popcorn, or carrot consumption. Intake of M&Ms was significantly higher among obese compared to healthy weight women ($F(1, 74) = 4.139$, $p = 0.045$), with obese women consuming an average of 43.1 kcals more M&Ms.

Total taste test intake was positively correlated with disinhibition of control ($r = .266$, $p = .018$) and food craving total score ($r = .238$, $p = .035$). Intake was not correlated with BMI or any measures of AB pre or post-training.

*Estimated Caloric Consumption*

After the taste test and image ratings, participants were asked to estimate how many calories they consumed during the taste test. One participant did not provide a response. There were no significant main or interaction effects of weight group ($F(1, 73) = 2.479$, $p = 0.120$) or attention condition ($F(1, 73) = 2.718$, $p = 0.104$). The mode of all responses was 100 kilocalories (range 0-1500 kilocalories). Obese women reported higher mean consumption (M = 284.25, SD = 476.72) than healthy weight women (M = 152.45, SD = 119.66) *(ns)*. Despite nearly equal caloric intake during the taste test between AR (166 kcals) and no-AR (175 kcals) attention groups, women in the no-AR group overestimated how many calories they consumed (M = 270 kcals) and women in the AR group underestimated intake (M = 157 kcals) *(ns)*.

**Aim 3**

The third aim was to examine whether there was a relation between type of training (AR or no-AR) and food intake and if the link was mediated by AB to unhealthy food cues (a proximal mediator) and/or food craving (distal mediator) among obese women.

***Hypothesis 3a.***

In line with Franken's neurocognitive model of obesity, food craving was hypothesized to partially mediate the relationship between attentional training and food intake among obese women. It was hypothesized that the relation between type of training (AR or no-AR) and food intake would be partially mediated by pre to post-training change in VAS food craving scores. In other words, the strength of the relationship between type of training (X) and food intake (Y) was expected to be reduced, but not diminished, when controlling for food craving (W).

***Hypothesis 3b.***

It was hypothesized that the strength of the relationship between type of training (AR or no-AR) and food intake would be partially mediated (e.g., reduced but not diminished) by pre to post-training change in AB to unhealthy food cues.

**Statistical Analysis:** A multiple step multiple mediation model (106) that included AB and craving as possible mediators was tested (**Figure 2**). Structural equation modeling (SEM) analyses were conducted using AMOS 5.0 (8) according to established methods using a binary predictor variable (X) and continuous mediators (M, W) (120).

First, variables for craving and AB were computed. AB was computed by subtracting post-training AB index scores for unhealthy cues from pre-training scores. A

single index of food craving was computed by subtracting post AR craving VAS scores from pre AR craving VAS scores. The hypothesized mediation model was evaluated through analysis of direct and indirect effects among the variables in the model. Direct pathways between attention condition and energy intake during the taste test, and indirect pathways through food craving and AB were tested according to established methods (106).

The goodness of fit of the model to the data was evaluated using empirically established indices of model fit (119). Favorable fit indices include a $\chi^2$ value closer to zero with a $p$ value greater than 0.05, a Comparative Fit Index value greater than 0.90 (CFI; 22), a Tucker Lewis Index greater than 0.90 (TLI; 230), and a Root Mean Square Error of Approximation value of .08 or lower (RMSEA; 216). Lower RMSEA values ($\leq$ .05) are preferred, given that smaller values are indicative of a better fit (119). Unstandardized path coefficients were examined (106).

**Mediation Model**

A structural equation model of craving and AB as mediators of the association between attention condition and food intake was examined. Intercorrelations among variables are presented for the entire sample (**Table 7**). The total effect of attention condition (X) on food intake (Y) was partitioned into direct and indirect effects using the following equation: $c = c' + a_1b_1 + a_2b_2 + a_1a_3b_2$. Here, c comprises the total effect between X and Y, which is equal to the direct effect of X on Y (c′) plus the sum of the indirect effect through M ($a_1b_1$), the indirect effect through W ($a_2b_2$), and the total indirect effect ($a_1a_3b_2$).

Among the sample as a whole, the overall model had poor fit with the data (N = 79; $\chi^2$ (6) = 10.145, $p$ = 0.119, RMSEA = .094 [CI = .000 – .191], CFI = .000, TLI = .000). Training type was associated with pre to post-training change in AB (B = -17.23, $p$ = .004) with a small-medium effect size (**Figure 9**).

The total indirect effect of training type through craving on food intake was 0.000, and the total indirect effect of training type through AB on food intake was -0.200. This means that when AB increases by a score of 1, food intake (in kcals) decreases only 0.200. The total effect of training type on food intake (direct and indirect) was also not significant (B = 8.493, $p$ = .824). There was no difference in food intake between training condition.

In obese women (n=36), the sample size was too small to be run with SEM. Hierarchical multiple regression was performed to detect main effects of training type and the mediator variables (AB, food craving) on food intake. The independent variable, training type, was entered into the equation first, followed by the mediator variables individually.

There was no main effect of training type ($B$ = 47.488, $\beta$ = 0.126, $t$(35) = 0.738, $p$ = 0.465) and neither AB nor food craving mediated the relationship between training type and intake.

# CHAPTER 5: DISCUSSION

## SUMMARY

The present study had two primary purposes, derived from an adapted addiction model of obesity. This study sought 1) to measure differences between satiated obese and healthy weight women in food craving and food-related attention and 2) test the feasibility of single session AR as a strategy for modifying AB toward food cues, food craving, and food intake. This study used a visual probe task modified from studies of addiction to assess AB to food stimuli in satiated obese and healthy weight women. An AR task focusing attention toward healthy food stimuli was randomly assigned to half of the participants in each weight group. Pre and post-training AB to food stimuli was compared between women who completed the AR and a non-AR attention condition. This study was the first to use an AR task among obese women to compare pre and post-training AB to varying food and nonfood cues. For the purposes of this discussion, the majority of work discussed is specific to visual probe data.

The overarching conclusion from this study is that no straightforward answer can yet be provided to the question of whether satiated obese women are more attentive to unhealthy (e.g., high calorie, palatable) food stimuli than healthy weight women and if attention is susceptible to manipulation using a computer-based AR strategy adapted from the addictions.

Attention to food was measured through AB to food pictures, subjective measures of eating behavior and reports of hunger/craving, and objective measures of healthy and unhealthy taste test food consumed.

Too few studies on retraining AB in obesity have been conducted and measures most commonly used have yielded contradicting results, leaving many questions currently unresolved. The present study yielded a number of interesting findings, which may benefit future replication studies. These findings are discussed in the following paragraphs followed by study strengths, limitations, and conclusions.

## Attentional Bias

In order to evaluate the effect of AR on obese and healthy weight women, it was essential to examine initial (i.e., pretraining) differences in AB. Our assumption was that there would be larger biases in both food-related attention relative to nonfood cues and biased attention to unhealthy relative to healthy food cues among obese women but no biases would be present among satiated healthy weight women.

An attentional avoidance (i.e., negative AB) of food in food:neutral trials or unhealthy food cues in food:food trials can also be considered a vigilance toward nonfood/healthy food cues. The visual probe task is capable of measuring two primary components of attention: initial orienting of attention and maintained attention. Orientation of attention focuses on evaluation of one's initial, or automatic, recognition of food whereas maintenance of attention (what was measured in the present study) instead refers to how easy or difficult it is to disengage attention from a particular stimulus.

To reiterate, faster RTs to unhealthy food relative to healthy food images on food:food trials reflects vigilance toward unhealthy food whereas longer RTs signifies a difficulty to disengage attention. AB index scores were calculated by subtracting the RTs

to identify probes that replace healthy food targets from RTs to identify unhealthy food targets in food: food trials (160). Positive AB index scores represent a bias in attention toward unhealthy food in food:food trials. Negative AB index scores represent a bias in attention toward healthy cues (and away from unhealthy food cues) (200).

**Pre-Training Attention Bias Data**

This was the first study to examine differences in attention to different categories of food between healthy weight and obese satiated females using the visual probe task. Healthy weight women responded faster to probes replacing healthy and unhealthy food pictures than obese women and demonstrated significantly more negative AB scores for unhealthy food cues. Unlike healthy weight women, obese women showed no discrimination in AB toward one type of food cue over the other.

Our findings do not support a tendency of obese women to approach food stimuli but instead support the notion of attentional avoidance of food, particularly unhealthy food, cues. Obese women initially orient their attention (100 ms visual probe task) preferentially toward food relative to neutral stimuli and particularly orient to palatable food cues when compared to healthy weight women in states of both hunger (170) and satiety (45; 170). Trials with stimulus durations of 500ms (such as those used in the present study) or more are generally assumed to measure maintained attention or delay of attention disengagement (74) and findings are less conclusive as to whether obese women have trouble disengaging from food cues (i.e., heightened attention) or practice avoidance of food cues (i.e., reduced attention).

Studies using eye-tracking or ERP report an avoidance of high-calorie food stimuli in obese persons (170; 258) whereas measures of reaction time have failed to

provide evidence of approach-avoidance tendencies for food stimuli among the obese (45; 258). We may not have found significant AB pre or post in obese women possibly because of issues innate to the parameters of the task itself. It is feasible that using 500ms stimulus duration may have masked innate differences in AB between groups. Even with stimulus durations as short as 500ms, attention can shift many times between task stimuli (74). Reaction time scores using trial durations longer than 500ms do not necessarily tell to which image attention was directed the longest, only where attention was focused at stimulus offset (34; 78). Using a longer stimulus duration creates difficulty in interpretation of visual probe task results and could provide an explanation as to why we did not find differences in maintained attention between weight groups or attention conditions. Had we utilized a shorter stimulus duration we could have measured orientation of attention and may have seen clear biases in attention toward one cue type.

Obese women assigned to the AR group averaged a positive AB score for unhealthy foods at pre-training that was significantly different from the pre-training negative AB score of healthy weight women in the AR condition and different from the negative AB score of obese women in the no-AR condition. The baseline difference between obese and healthy weight AR groups was not unexpected though it was surprising that there was no overall AB score difference between weight groups pre-training. What was unanticipated, however, was that obese women in the AR and no-AR conditions differed significantly in baseline AB scores. Several analyses were conducted to evaluate possible reasons for baseline differences (e.g., eating behaviors, demographics) and nothing emerged to help explain the anomaly.

With regard to measurement of AB to food:neutral trials, contrary to the hypothesis we did not find that obese women were more vigilant to food cues than healthy weight women pre-training. Neither weight group displayed a pre-training bias toward food relative to neutral cues. Our findings among obese women are in contrast with findings of Castellanos et al. (45), who reported enhanced duration bias toward food (food:neutral trials only used) in hungry obese compared to healthy weight females that was reduced in satiated healthy weight women but maintained among the obese. Though there were no differences between groups in AB scores for food:neutral cues, we found an AB toward healthy food cues among healthy weight women. This may imply the importance of food type in measurement of maintained attention.

It is also feasible that differences in findings are associated with differences in methods of satiating participants or task parameters between studies. The first review of Attentional Processing of Food Cues in Overweight and Obese Individuals was published in 2012 (168) and notes the variety between study designs makes it difficult to compare AB results across studies.

Previous studies have tested satiated participants before measuring AB to food cues, however, the studies food-deprived participants for 10-11 (45) and 17 hours (170) before beginning the study. This period of food deprivation may have required restraint for many women and it is possible that satiating participants after an abnormal period of deprivation led to feelings of 'disinhibition,' which may have been reflected in AB toward food among satiated obese women in previous studies.

Other small differences in study design may play an important role in variations in study results. Whereas our study only included females, Castellanos et al. (45)

included obese male and female adults. Participants in our study were asked to eat their usual lunchtime meal to satiety before testing and record food intake before starting the study, Castellanos et al. (45) tested participants at various times of day. In addition, Castellanos et al. (45) used a within-subjects design for hunger and satiety and allowed participants to consume as much milk shake as desired to feel satiated, resulting in average energy intake of 300-400 kilocalories. Nijs et al. (170) used a between-subjects design and fed participants a fixed amount of milk shake that contained 600 kilocalories.

### Attentional Retraining

The central assumption of this study was that a single session of AR, in comparison to a no-AR condition, would differentially affect AB toward unhealthy food cues in obese women. Our data are the first to demonstrate that manipulating attentional focus away from unhealthy food using a modified visual probe task can alter AB scores for food-related stimuli in obese women. The hypothesis that AR would modify AB, food craving, and food intake was not supported but there were differences in AB scores between obese women in the AR and no-AR conditions.

Among obese women, AB scores became *more negative* with training. In support of our hypothesis, the greatest effect on AB was seen in obese women. Post-training AB index scores did not differ significantly from zero in either weight group or attention condition, however, AB scores among obese women in the AR group changed significantly from a positive bias pre-training to a negative bias post-training. The opposite effect was present among the obese no-AR condition. Interpretation of these

data is not straightforward because of the differences in AB at pre-training between AR and no-AR participants in the obese group.

In contrast to the effect present among obese women, AB scores to unhealthy food cues increased (i.e., became less negative) following training among healthy weight women. Even though there was no hypothesis as to how AB toward unhealthy cues would change following AR among healthy weight women, the intention of training was not to make any participants *more attentive* to unhealthy food cues. The increase in AB was present in healthy weight women in both attention conditions. It is possible that healthy weight women are more responsive to internal signals that regulate hunger and satiety and as hunger levels increased through the study unhealthy foods became more salient. Evolutionarily, selective detection of high-calorie foods is an extremely adaptive survival mechanism and is present in both animals and humans.

**Effect of AR on Food Intake**

Obese women consumed significantly more M&Ms than healthy weight women during the taste test but there were no differences in food intake between women in the AR and no-AR conditions. Previous findings from the AB literature comparing taste test intake between satiated overweight/obese and healthy weight participants are mixed.

Studies have reported that overweight/obese women did (258) and did not (170) consume more kilocalories than satiated healthy weight women. In the latter study (170), increased food intake during a bogus taste test was observed in hungry obese subjects but food intake did not significantly differ from that of satiated healthy weight women (170).

There were no differences in level of self-reported hunger between obese and healthy weight women before or after the taste test. If obese women were in fact hungrier than they self-reported by the time of the taste test this could explain their increased intake. Obese women may have underreported levels of hunger (consciously or unconsciously) in response to feelings of guilt or shame (223) or due to an internal conflict between a desire to eat and a desire to lose weight (168). There is substantial evidence that obese women are more likely to underreport body weight and food intake than healthy weight women (54; 99).

The foods selected for the taste test in this study were adapted from previous research (170; 258), with the addition of plain popcorn and baby carrots as healthy food options. Hedonic ratings were acquired during the taste test for each of the four foods. In general, obese and healthy weight participants rated the taste test foods the same for liking, wanting, desire to eat, how much smell influenced desire to eat, flavor of food, and sweetness of food. Taste test hedonic ratings were correlated with taste test intake and baseline food preference ratings. How much participants rated liking and wanting to eat the four taste test foods during baseline preference ratings was significantly positively correlated with liking and wanting ratings during the taste test itself. Amount of food consumed was not correlated with self-report ratings of food liking and wanting but intake was positively correlated with baseline food craving and several indices of eating behavior.

**Eating Behaviors, Body Weight, and AB**

Obese women may exhibit avoidant behavior toward food stimuli due to a fear of becoming disinhibited when exposed to salient foods (110). In line with AB results, there

may exist an approach-avoidance tendency whereby the obese have internal conflict when confronted with palatable food cues. The conflict takes the form of an initial desire to approach (initial attentional orientation) followed by a conscious desire to lose weight (attentional avoidance of food cues) (168).

Generally, the research supports the idea that obese women or those with high levels of disinhibition, food craving, or external eating have heightened attention toward food cues, specifically palatable food cues. In our study we found no relationships between any self-report measures and pre or post AB scores, though disinhibition was positively associated with BMI and food intake, consistent with previous research (137) in a variety of samples (259; 268), including obese (BMI > 32) (33), severely obese (BMI > 40) (118), non obese (BMI < 28) (145), and premenopausal women (138).

One reason for the lack of relationships between measures of attention and indices of eating behavior and food craving could be due the lack of reliability of self-report measures. Underreporting on questions related to eating issues is particularly common among obese individuals (222). Obese women in our study may have inaccurately reported on self-report measures or underreported levels of craving and hunger on VAS scales throughout the study.

Additionally, no AB research has evaluated how impulsivity is associated with biases toward food stimuli or may interfere with attention modification. A study conducted in 2010 (117) focused on the relationship between inhibitory control and high calorie food consumption. Among self-reported chocolate cravers, training to inhibit responses to chocolate stimuli resulted in significantly reduced chocolate consumption. Given that executive control decreases as a result of long-term addictive behaviors (262)

and trait impulsivity has been identified as a vulnerability factor for overeating (103; 104) in obese individuals, strengthening inhibitory control might be an effective strategy to help regain control over food intake.

**Effect of AR on Craving**

Study results do support the common belief that women generally eat the types of foods they report craving. All participants reported craving sweet foods more than high fat and high carbohydrate foods. Obese women reported more cravings for high fat foods than healthy weight women and this was reflected in elevated taste test intake of high fat foods among obese women.

Food cravings often result in food intake of the craved or similar food (113; 255). There were not significant correlations between Food Craving Inventory scores and intake of any particular food in the taste test. This could be because previous findings linking craving and intake of the craved food were primarily based on self-report (113; 255) whereas our study used both subjective measures of craving and objective measures of food intake.

From pre to post training self-reported craving increased among all participants. Our finding is supported by studies of AR in addiction using smoking and alcohol cues finding that exposure to substance-related cues enhance drug cue-related attention and increased AB to drug-related cues (via attentional training) led to increased craving (74). The question of whether attentional training lasting longer than a single session can change the intensity of food cravings in obese individuals remains unresolved.

There was no difference in craving between participants in the AR and control groups post training or prior to the taste test. Effects of laboratory studies of AR among

smokers and social drinkers have also shown no reduction in craving following training (9; 75; 79; 157; 199).

### Mediators of Training and Food Intake

The third aim was to examine whether there was a relation between type of training (AR or no-AR) and food intake and if this link was mediated by food craving and/or AB to unhealthy food cues.

This model diverges from the established model of Franken (84). According to the model, the mutually enhancing effects that the attention to food and food craving exert on each other ultimately lead to seeking and consuming food. It was hypothesized that the effect of AR on food intake would be partially mediated by food craving and mediated partly through reduced AB. A multiple step mediation model (106) was tested (**Figure 2**). Mediation analysis tested relations between variables and identified the influence exerted on a given variable by another (183).

Our hypothesis that food intake would differ as a function of training group was not supported in the analyses conducted in our study. The largest difference in food intake was present in the obese group (n=36) between AR and no-AR conditions but the model was underpowered to detect differences using SEM and could not be tested.

Among the full sample (N=79), we found a significant relationship between training and change in AB but we do not believe the mediation hypothesis is supported given the addition of the mediator had no effect on the direct pathway between training type (X) and food intake (Y). Most likely due to an underpowered model, results show our model does not fit the data well.

A stronger and more effective test of these relationships would involve a longitudinal training study or a larger sample size comprised of obese women.

## STRENGTHS, LIMITATIONS, AND FUTURE DIRECTIONS

### Strengths

This study made several contributions to the existing literature on AB, food craving, and eating in the absence of hunger. From a research perspective, the design of the present study replicates the existing data reported in the three known studies that have examined AB, food craving, and food intake in healthy weight and obese samples of women (45; 170; 258). In addition, the inclusion of a pre-post design to test a strategy with potential research and clinical implications provides a novel addition to the existing literature on obesity treatment and obesity prevention. This is promising considering currently available AB literature on healthy weight individuals is primarily conducted in the context of eating style, affect, or merely as a comparison to an obese sample. No research thus far has effectively utilized AB findings among healthy weight women from the community in an effort to further obesity prevention efforts.

The use of a community sample in the present study further increases the generalizability of results over previous studies conducted in undergraduate samples (170; 258). Clinically, the present sample may reflect the type of clientele likely to seek weight loss treatment in the community or provide information on healthy weight individuals who are at-risk for overeating and weight gain. If so, providers may be able to utilize study findings to increase their understanding of how environmental cues trigger AB, food craving, and food intake among women.

This is the first study to administer an AR intervention in the laboratory and thus allowed for assessment of participant burden. When AR is administered in an EMA setting, each bout is brief and lasts no more than a few minutes. However, in the laboratory AR can exceed one hour of continuous testing in a single session (9; 149). Completion of a participant survey following testing revealed that although most participants found the task 'boring,' the length of the AR session was not burdensome.

Generalization of the effect of AR toward new food stimuli post-training is important as it is vital for individuals to not only be able to disengage attention to cues used in the AR intervention but also to other unhealthy food stimuli present in the environment. This generalization effect has been shown in one previous study of alcohol-related stimuli (200) but has commonly not been shown in previous single session AR intervention studies (75; 199).

**Limitations and Future Directions**

This study has a number of limitations. First, the sample size used in this study is not large enough to allow inferences about the impact of AR on AB, craving, and food intake to be made. Despite the 'pilot' nature of this study the results are promising and demonstrate the feasibility of administering food-related AR in a laboratory setting.

Second, measuring AB with computer-based reaction time tasks such as the visual probe is less accurate then employing more direct measures of assessment such as eye-tracking or event-related potentials (ERP). To our knowledge, there are no published data indicating that AR influences eye saccades in any research area. Therefore, replicating the present paradigm using more direct measures of AB in cross-sectional and

longitudinal studies is suggested. In addition, There was no attend-unhealthy condition to compare to the avoid-unhealthy condition.

Third, only females were included in the present study, therefore, any effect of the AR intervention or differences in AB between healthy weight and obese groups are not generalizable to males of any age group. In addition, the relevance of Franken's model adapted for obesity is not valid for males or overweight women. The decision to study females was based on research indicating gender differences in food craving and eating style (36; 41). The absence of an overweight group of women who are at risk of becoming obese due to lifestyle factors such as problem eating behaviors also limits generalizability of findings. Further, findings do not generalize to children or adolescents.

Using AR as an obesity-prevention approach may be most beneficial among those at risk for gaining weight such as overweight women or children/adolescents at risk for weight gain. It is possible that among obese adult women, neural pathways in the brain are already 'hard-wired' from engaging in aberrant eating behaviors for extended periods of time. For these women, a single session of training is likely no match for the cognitive-motivational biases to food that have been strengthened over time through repetitive conditioned behavior. Therefore perhaps one reason behavioral weight management strategies have to date been unsuccessful long-term in adults is because the biological connections that drive the behaviors are firmly established by adulthood and override attempts to change innate cognition or behavioral responses.

Given that neural connections are not fully formed until early adulthood it is possible that cognitive strategies such as AR will have the most impact when connections

are still actively developing prior to adulthood. This hypothesis is based on a prominent theory proposed by Donald Hebb in 1949 suggesting that neuronal firing patterns contribute to psychological processes including learning and memory (108). Due to the paucity of research on AB in children and adolescents, extension of the present paradigm to younger cohorts is warranted. Studying AB among adolescent samples is particularly relevant to determine the utility of AR as a strategy for obesity prevention. Intervening early with cognitive approaches such as that outlined in this proposal may establish neural connections that are consistent with weight management.

Fourth, the use of self-report questionnaires to acquire information on eating and weight history is a limitation due to the inaccuracy of retrospective recall. To account for this, questions were open-ended to discourage biased responding. Unfortunately, self-reported height and weight were used to screen participants and inaccuracies in reporting resulted in three women with BMIs in the overweight category participating in the study. Upon analysis of AB data, it was evident that the three overweight women more closely resembled the healthy weight women of the sample and their data was combined with the healthy weight group for all analyses despite exceeding the healthy weight BMI cutoff of 25 $kg/m^2$.

Fifth, the cross-sectional nature of the present study limits the ability to determine causal inferences. That said, the use of a single session of AR is only a starting point for future studies to determine the utility of AR as an addition to current programs for prevention and treatment. Increasing the number of AR sessions is likely to increase the effect on AB, presuming AR parallels results of other modes of cognitive training (128; 129; 158).

If AR is effective at altering AB it can be expected that AR will also result in changes in other measures of attention. In order to use AR fully it must be generalizable beyond the stimuli used in the study tasks. Demonstrating that the effect of AR is not specific to study stimuli has been a problem in previous studies (199). More research is warranted to determine whether results generalize to other measures of attention, such as other computer tasks and more direct measures such as eye tracking. AR can also be used longitudinally via ecological momentary assessment (EMA), similar to its current use as an aid for smoking cessation (Waters, in progress). Use of AR in EMA settings has possibilities for preventive approaches with youth who are at-risk for obesity.

Sixth, not only was this study cross-sectional but it was conducted in the laboratory, which reduces ecological validity. Should the study be conducted in a naturalistic setting results may differ, particularly in light of the fact that participants were asked to eat food. Further, food affects more than just the visual system and AR in the present study targeted only visual attention. Food wanting is intrinsically linked to the olfactory system and smell was only addressed during the taste test using VAS subjectively. However, it is unknown how the smell of foods during the taste test influenced food intake or food craving of different individuals. Future AR studies will likely be required to determine the role of other senses in modification of AB, food craving, and food intake.

Seventh, the images used in the tasks may not have been equally appealing to all participants. The sample was comprised of a wide variety of ethnicities and age ranges and even though attempts were made to ensure that a wide variety of images from various food categories were chosen, anecdotally it is to be noted that some participants indicated

they did not know what some images were (e.g., mango, gumballs) and they mentioned images they wished had been present that were not included (e.g., ice cream, collard greens, meatloaf). Based on participant responses and conversation with them it was evident that the images that were most salient throughout the tasks was specific to each individual and varied across the sample. With regard to the foods selected for the taste test, unbuttered and unsalted popcorn was used in the taste test as the second healthy food option, however, the image used to assess baseline hedonic ratings of food liking and wanting showed a bowl of popcorn but did not clearly indicate whether the food was plain or buttered. The popcorn image's ambiguity could partly explain why there were no differences between weight groups in liking and wanting for popcorn. Anecdotally, during completion of the baseline hedonic ratings, several of the obese women commented that they really enjoyed eating buttered popcorn, especially when they were at the movies. Verbal comments such as these were only made by women in the obese group though it is very likely they are not specific to obese women.

## CONCLUSIONS

Retraining attention toward healthy food cues may have utility as a strategy for modifying AB to unhealthy food cues in obese women. Although there were no differences in food craving and acute food intake between women who completed the AR and no-AR conditions, the single session AR used in this study did show greater effects in modifying AB to unhealthy food cues among obese women compared to healthy weight women, with the greatest change present among obese women who completed the AR. Results may provide further insight into the relationship between AB and food

consumption. Obese participants in our study ate significantly more snack food than healthy weight participants during the taste test and this difference is not easily explained by differences in self-reported hunger or food craving.

The present study sets the stage for future replication studies, bridging the gap between previous research identifying food-related AB in obese women and studies in the addiction literature that have successfully used AR to modify AB to drug-related cues.

Table 1. Participant Demographics

| | N=79 | HW (n=43) | OB (n=36) |
|---|---|---|---|
| Age (years) (19-60) | 33.00 (11.83) | 31.33 (11.38) | 35.00 (12.21) |
| Height (inches) (59.5-71) | 65.00 (2.60) | 65.09 (2.58) | 64.89 (2.66) |
| Weight (lbs) (105.6-295) | 172.05 (49.67) | 134.08 (17.11) | 217.40 (35.51) |
| BMI ($kg/m^2$) (17.7-52.3) | 28.64 (8.29) | 22.20 (2.14) | 36.33 (5.98) |
| Bodyfat (15.5-53.4) | 34.18 (11.12) | 26.01 (6.15) | 43.93 (7.11) |
| Waist (inches) (24-50) | 33.37 (7.22) | 27.77 (2.46) | 40.06 (4.95) |
| Hip (inches) (34-57) | 42.13 (5.89) | 37.56 (2.34) | 47.58 (3.80) |
| WHR (inches) (.66-.98) | .78 (.073) | .74 (.042) | .84 (.06) |
| Marital Status | | | |
| Single | 44 (56%) | 27 (63%) | 17 (47%) |
| Married | 21 (27%) | 10 (23%) | 11 (31%) |
| Divorced | 5 (6%) | 1 (2%) | 4 (11%) |
| Living Together | 9 (11%) | 5 (12%) | 4 (11%) |
| Education | | | |
| High School | 7 (9%) | 1 (2%) | 6 (17%) |
| Partial College | 14 (18%) | 7 (16%) | 7 (19%) |
| Completed College | 35 (44%) | 21 (49%) | 14 (39%) |
| Partial Grad School | 5 (6%) | 5 (12%) | 0 (0%) |
| Completed Grad School | 18 (23%) | 9 (21%) | 9 (25%) |
| Race | | | |
| Caucasian | 39 (49.5%) | 27 (63%) | 12 (33%) |
| African American | 28 (35.5%) | 9 (21%) | 19 (53%) |
| Asian | 8 (10%) | 6 (14%) | 2 (5.5%) |
| Hispanic/West Indian/Other | 4 (5%) | 1 (2%) | 3 (8.5%) |
| Employment | | | |
| Full-time | 50 (63%) | 29 (68%) | 21 (59%) |
| Part-time | 10 (13%) | 7 (16%) | 3 (8%) |
| Unemployed | 18 (23%) | 6 (14%) | 12 (33%) |
| Retired | 1 (1%) | 1 (2%) | 0 (0%) |

BMI – body mass index, WHR – waist to hip ratio

Mean (SD); *n* (%)

Table 2. Eating Disorder Diagnostic Scale Diagnoses

| Diagnosis | N=79 | HW (n=43) | OB (n=36) |
|---|---|---|---|
| No Diagnoses | 61 (77%) | 35 (81%) | 26 (72%) |
| Anorexia Nervosa | 0 (0%) | 0 (0%) | 0 (0%) |
| Bulimia Nervosa | 4 (5%) | 2 (5%) | 2 (6%) |
| Binge Eating Disorder | 3 (4%) | 0 (0%) | 3 (8%) |
| Subthreshold Bulimia | 9 (11%) | 6 (14%) | 3 (8%) |
| Subthreshold BED | 2 (3%) | 0 (0%) | 2 (6%) |

BED – Binge Eating Disorder
n (%)

Table 3. Self-reported Eating Behaviors, by weight group

| | N=79 | HW (n=43) | OB (n=36) | *p* value |
|---|---|---|---|---|
| EI | | | | |
| Restraint | 9.85 (5.09) | 10.26 (5.59) | 9.36 (4.45) | .440 |
| Disinhibition of Control | 7.18 (3.57) | 6.02 (3.29) | 8.56 (3.44) | .001 |
| Perceived Hunger | 5.34 (3.20) | 5.33 (2.92) | 5.36 (3.55) | .961 |
| FCI | | | | |
| High Fat | 1.92 (.70) | 1.75 (.59) | 2.13 (.78) | .016 |
| High Sweet | 2.75 (.98) | 2.76 (1.06) | 2.74 (.88) | .932 |
| High CHO | 2.19 (.66) | 2.13 (.66) | 2.25 (.65) | .438 |
| Fast Food | 2.81 (.91) | 2.77 (1.05) | 2.87 (.73) | .628 |
| Total Score | 2.36 (.60) | 2.29 (.57) | 2.44 (.62) | .267 |
| YFAS Total Symptoms | 2.04 (1.47) | 1.53 (1.14) | 2.64 (1.61) | .001 |
| EAH | | | | |
| negative affect | 1.67 (.81) | 1.49 (.58) | 1.88 (.98) | .032 |
| external | 2.77 (.81) | 2.72 (.88) | 2.83 (.72) | .567 |
| fatigue | 1.82 (.66) | 1.72 (.56) | 1.93 (.76) | .163 |

EI – Eating Inventory, FCI – Food Craving Inventory, YFAS – Yale Food Addiction Scale, EAH – Eating in the Absence of Hunger

Mean (SD)

Table 4. Self-reported Eating Behaviors, by ethnic group

| | N=79 | AA/other (n=40) | CA (n=39) | *p* value |
|---|---|---|---|---|
| EI | | | | |
| Restraint | 9.85 (5.09) | 9.25 (4.70) | 10.46 (5.46) | 0.293 |
| Disinhibition of Control | 7.18 (3.57) | 6.80 (3.28) | 7.56 (3.85) | 0.345 |
| Perceived Hunger | 5.34 (3.20) | 5.15 (3.13) | 5.54 (3.30) | 0.593 |
| FCI | | | | |
| High Fat | 1.92 (.70) | 2.17 (.76) | 1.67 (.54) | 0.001 |
| High Sweet | 2.75 (.98) | 2.64 (.76) | 2.86 (1.16) | 0.317 |
| High CHO | 2.19 (.66) | 2.32 (.67) | 2.05 (.63) | 0.071 |
| Fast Food | 2.81 (.91) | 2.87 (.76) | 2.76 (1.05) | 0.587 |
| Total Score | 2.36 (.60) | 2.45 (.60) | 2.27 (.59) | 0.198 |
| YFAS Total Symptoms | 2.04 (1.47) | 2.15 (1.27) | 1.92 (1.66) | 0.497 |
| EAH | | | | |
| negative affect | 1.67 (.81) | 1.45 (.54) | 1.89 (.97) | 0.013 |
| external | 2.77 (.81) | 2.66 (.84) | 2.88 (.78) | 0.239 |
| Fatigue | 1.82 (.66) | 1.68 (.62) | 1.96 (.69) | 0.054 |

EI – Eating Inventory, FCI – Food Craving Inventory, YFAS – Yale Food Addiction Scale, EAH – Eating in the Absence of Hunger
Mean (SD)

Table 5. Attention Bias Index Scores by Weight Group and Attention Condition

| | N=79 | | AR Avg n=39 | | No-AR Avg n=40 | | HW Avg n=43 | | OB Avg n=36 | |
|---|---|---|---|---|---|---|---|---|---|---|
| AB index score Unhealthy:Healthy Food | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Pre | -9.01 | 29.44 | -6.86 | 33.85 | -11.10 | 24.64 | -13.31* | 29.10 | -3.86 | 29.41 |
| Post | -4.73 | 35.81 | -9.47 | 41.60 | -0.11 | 28.89 | -3.23 | 25.02 | -6.53 | 45.83 |

AB – Attentional Bias; HW – Healthy weight; OB – Obese; AR – Attention Retraining; * value significantly different from 0 value at $p < 0.05$

Positive AB index scores represent a bias in attention toward unhealthy food in food:food trials.
Negative AB index scores represent a bias in attention toward healthy food (and biases *away from* food/unhealthy food cues)

Table 6. Attention Bias Index Scores by Attention Condition within Healthy Weight and Obese Groups

| | HW-AR n=21 | | HW- noAR n=22 | | OB AR n=18 | | OB noAR n=18 | | |
|---|---|---|---|---|---|---|---|---|---|
| AB index score Unhealthy:Healthy Food | Mean | SD | Mean | SD | Mean | SD | Mean | SD | d |
| Pre | -17.55* | 35.79 | -9.27* | 20.94 | 5.61 | 27.36 | -13.33 | 29.01 | 0.67 |
| Post | -6.48 | 32.59 | -0.14 | 14.85 | -12.97 | 50.93 | -0.08 | 40.53 | |

d – Cohen's d; AB – Attentional Bias; HW – Healthy weight; OB – Obese; AR – Attention Retraining
Mean (SD); * value significantly different from 0 value at $p < 0.05$

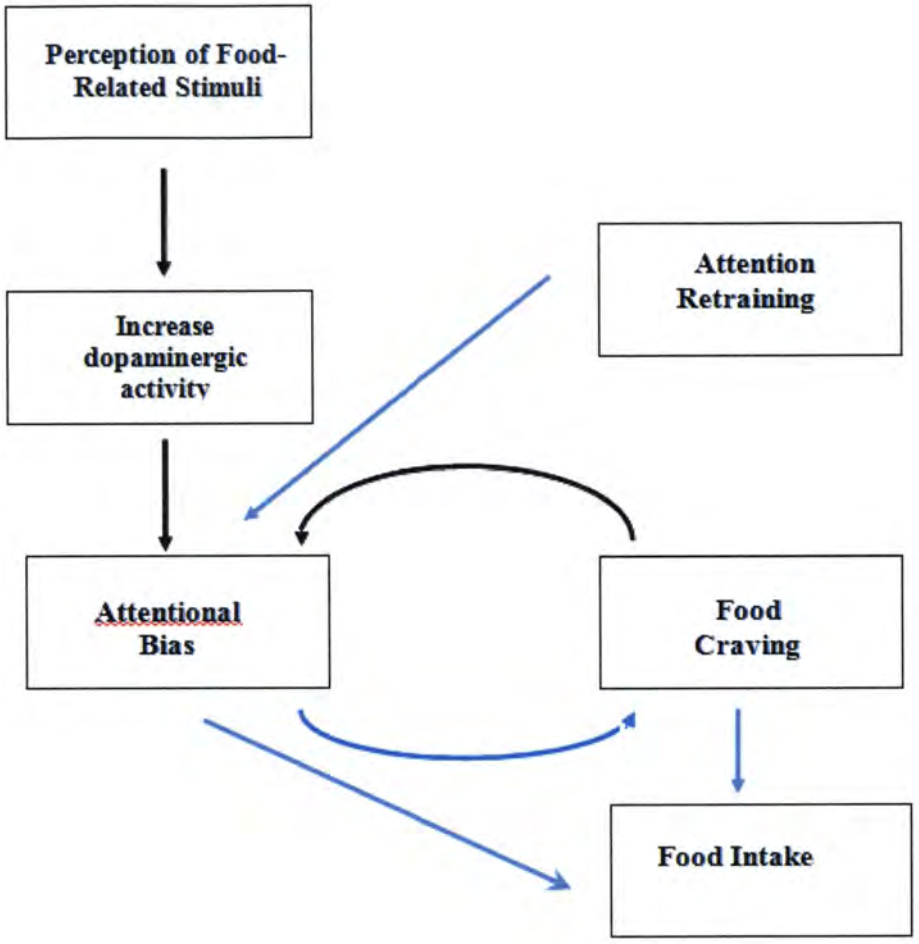
Positive AB index scores represent a bias in attention toward unhealthy food in food:food trials.
Negative AB index scores represent a bias in attention toward healthy food (and biases *away from* food/unhealthy food cues)

Table 7. Intercorrelations among indicator variables (N=79)

| | Variable | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 1 | Attention Condition | -- | | | |
| 2 | Attentional Bias | -.310** | -- | | |
| 3 | Food Craving | -.133 | .078 | -- | |
| 4 | Kcals Consumed | .025 | -.056 | -.086 | -- |

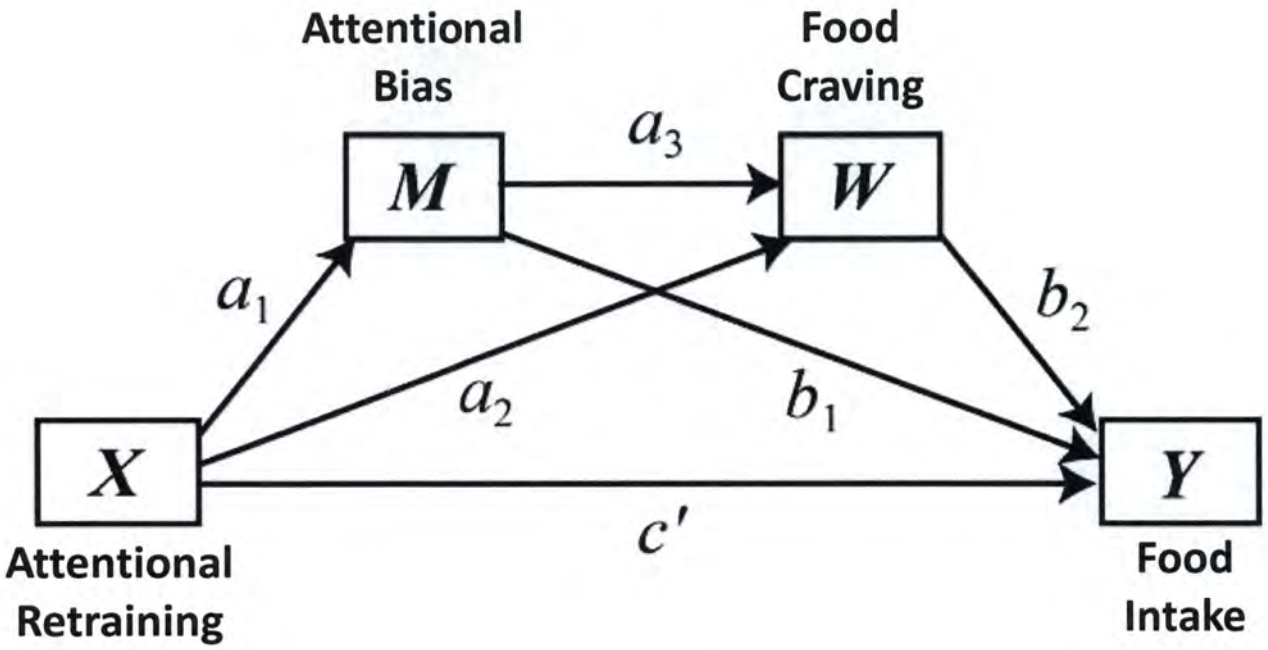
Kcals – Kilocalories; Food Craving = Pre-AR - Post-AR Visual Analog Scores for Food Craving.
*$p < 0.05$ (two-tailed); ** $p < 0.01$ (two-tailed)

Figure 1. Model of relationships between AB, food cravings, and food intake in obesity



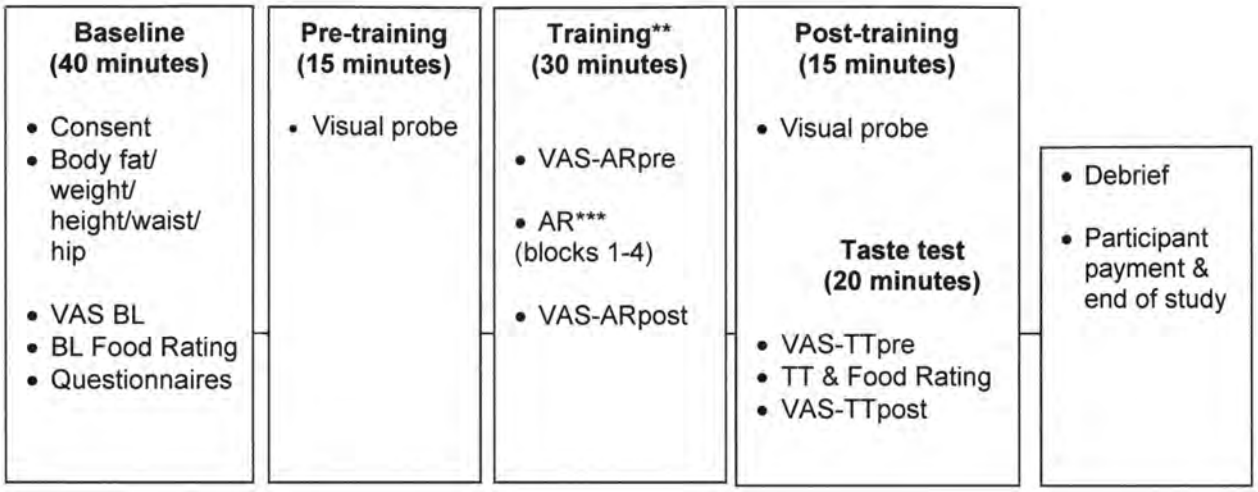

* proposed relationship that will be tested

Figure 2. Multiple step multiple mediation model




Multiple step mediation model testing relationships between attentional retraining (X) and food intake (Y), accounting for attentional bias (M) and food cravings (W) as mediators.

Figure 3. Timeline of study procedures, by study phase




AR*** = Modified visual probe task (AR) or standard visual probe task (no-AR)

VAS = Visual analog scales of hunger, satiety, desire to eat, and craving; ratings at baseline (BL), and pre and post attentional retraining (AR) and taste test (TT)

** = Either attentional retraining or no training, depending on group assignment
*** = Standard version or biased away from unhealthy food cues and toward healthy food cues, depending on attention condition

Figure 4. Attentional Bias Scores Pre and Post Training

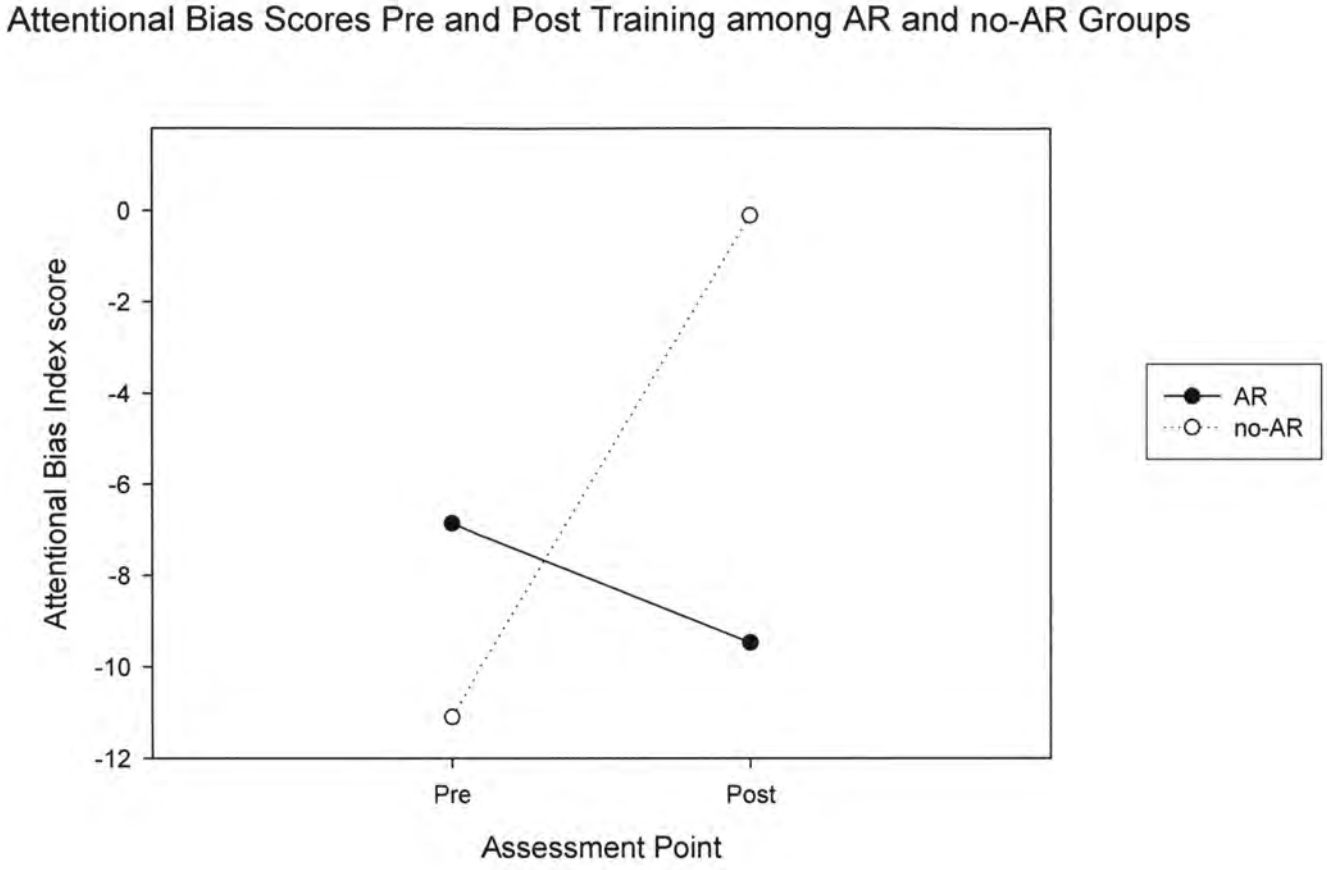


Figure 5. Attentional Bias Scores Pre and Post Training among Healthy weight and Obese Groups

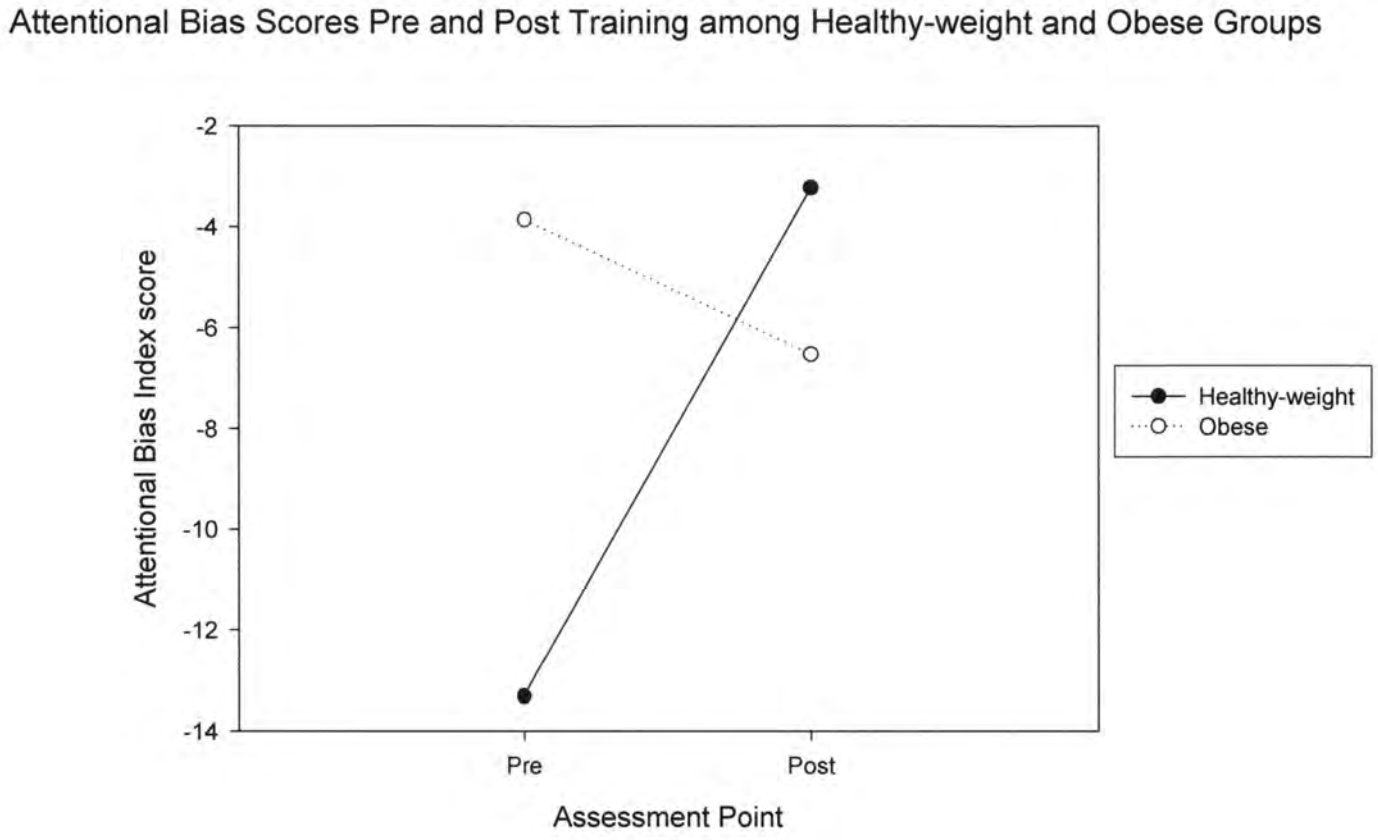


Figure 6. Attentional Bias Scores Pre and Post Training among Healthy weight and Obese AR and no-AR Groups

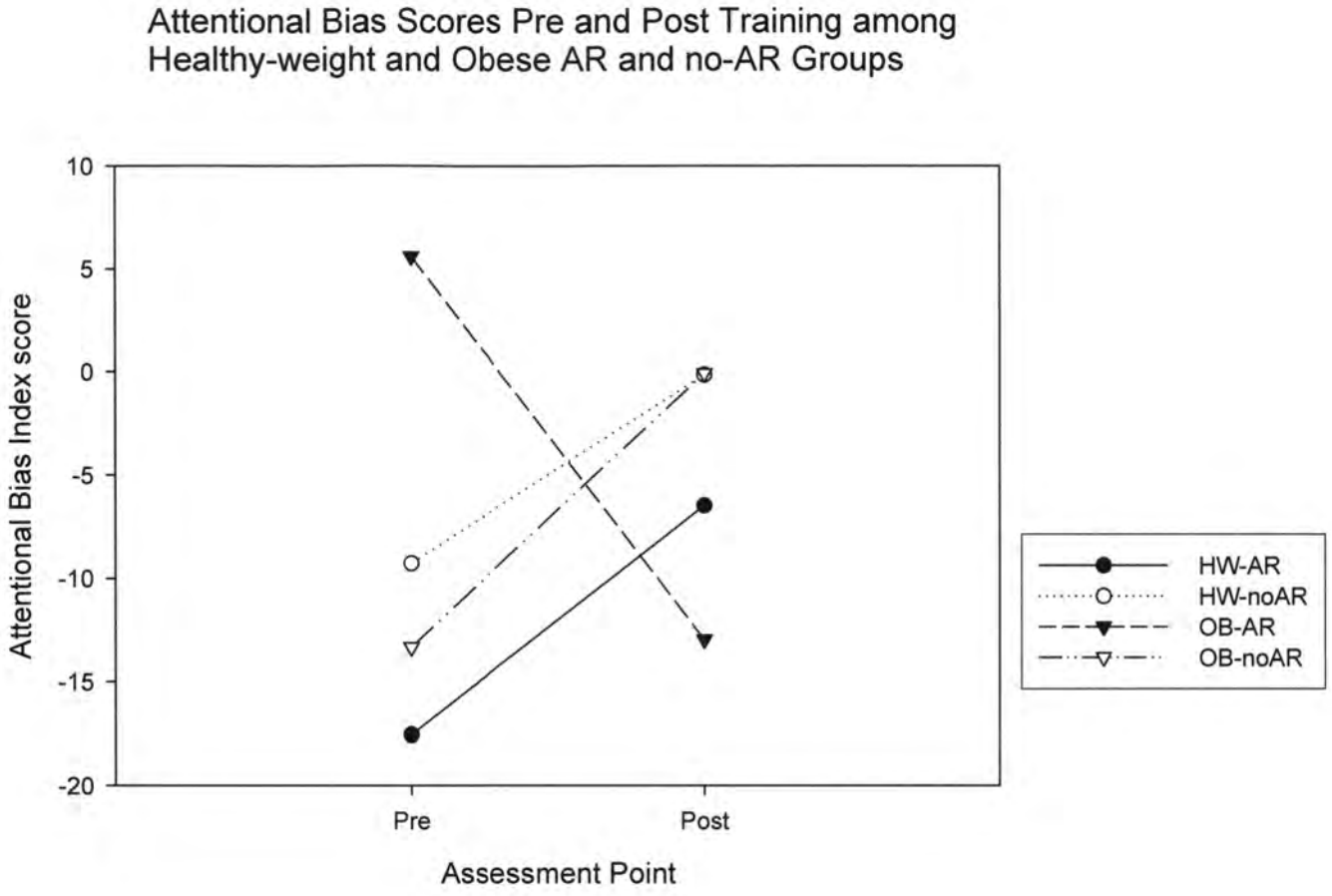


Figure 7. Taste Test Food Intake (kcals)

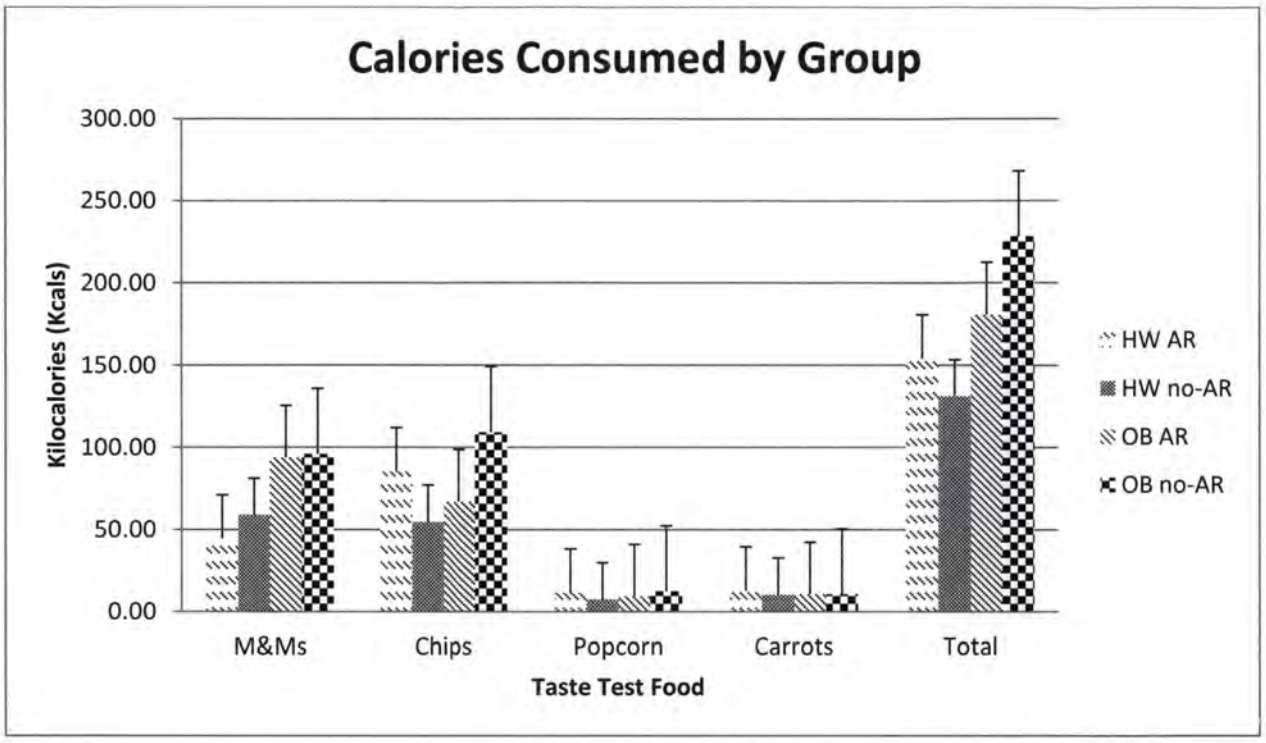


Figure 8. Taste Test Food Intake (grams)

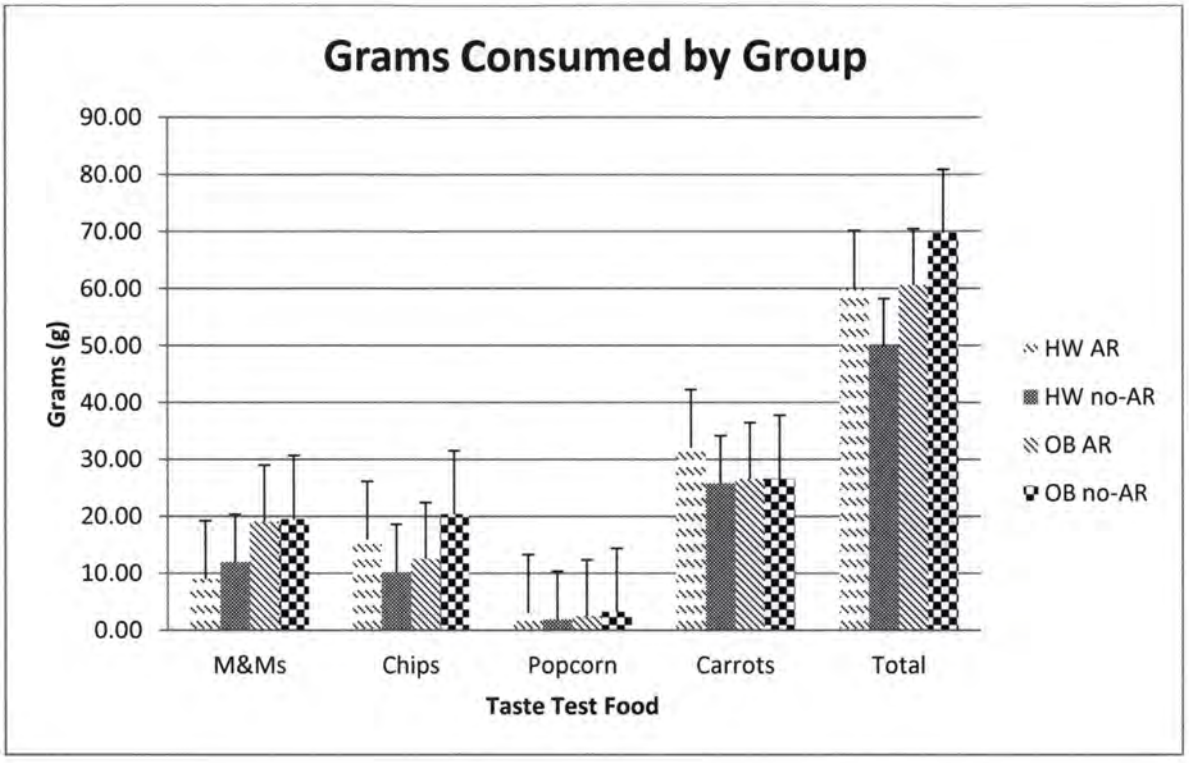
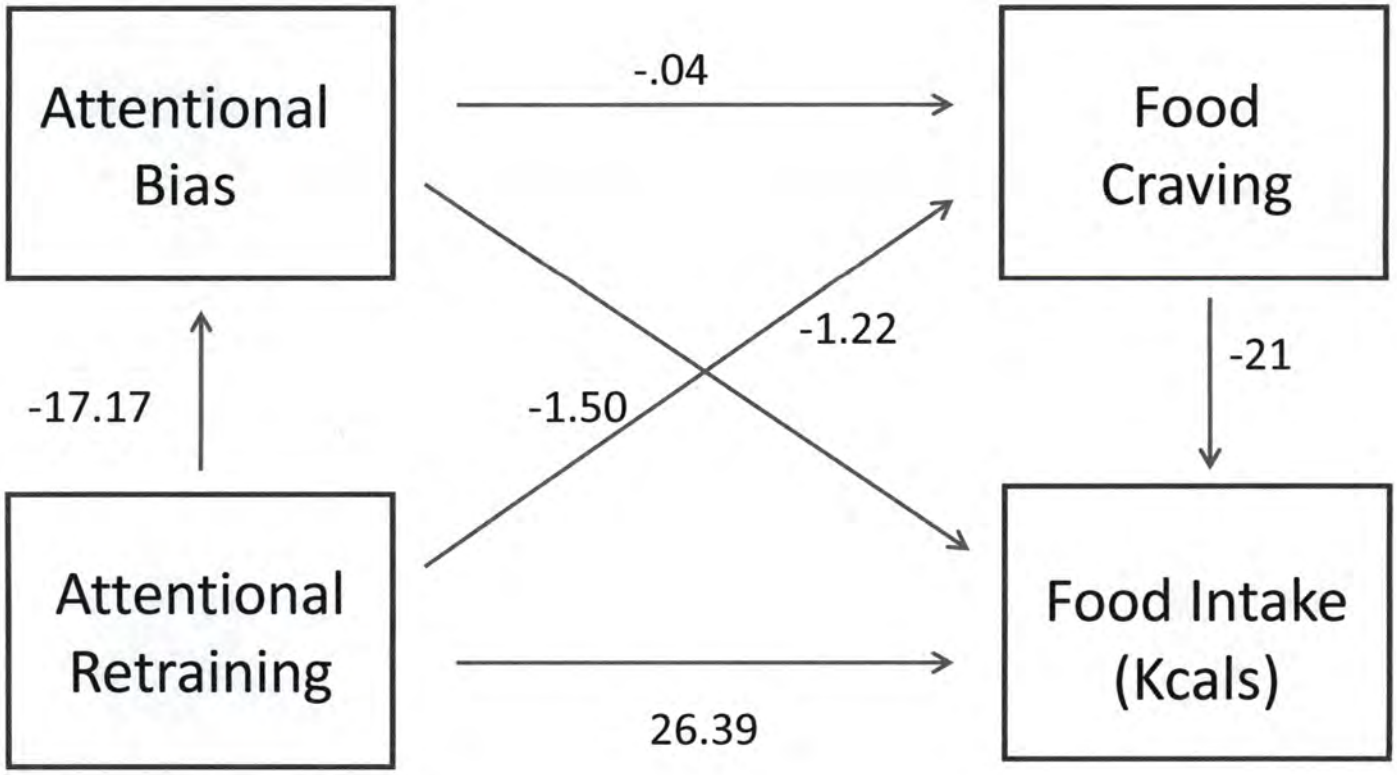


Figure 9. Mediation Model Unstandardized path coefficients (N=79)



Appendices

## Appendix A: Advertisements

**Seeking Volunteers**
Women are needed for a study on the effects of appetite on general information processing and reaction time. Must be non-smoking, and without major medical or mental health problems (ages 18 and up). Participation requires a single two and a half hour visit to the Uniformed Services University of the Health Sciences, during which you will fill out questionnaires, perform some tasks on the computer, and taste test four foods. Height, body weight, and body composition will be measured. Participants will receive compensation for study completion. For more information please call Elena Spieker at (410) 575-4009.

**Appendix B: Resources and mental health options**

All participants are being given this information on local resources where you can seek support services if you or someone you know may be interested.

**Mental Health and Crisis Resources**

**Anne Arundel County Community Warmline**
"Community Warmline" provides Anne Arundel County supportive assistance and links to community resources
410-768-5522
Hours: 24 hours a day, 7 days a week

**Pro Bono Counseling Project**
http://www.aacc.edu/healthservices/wellness.cfm
http://www.probonocounseling.org/
Mental health referral service for individual, couples, and family counseling, psychiatry, and other clinical concerns.
410-323-5800
131 West Quadrangle
Baltimore, MD 21210

**Montgomery County Crisis Center**

1301 Piccard Drive, 1st Floor
Rockville, MD 20850

240-777-4000 (V)
301-738-2255 (Mental Health Hotline)
240-777-4673 (Abused Persons Program)
240-777-4357 (Sexual Assault Crisis Hotline)
240-777-4815 (TTY)

The Crisis Center provides 24-hour telephone or walk-in crisis counseling, brief crisis stabilization, and help in obtaining services for individuals and families in a situational or mental health crisis, for adult abused persons and for sexual assault victims. There is no charge for crisis services.

**Addiction and Mental Health Center**

Montgomery General Hospital
18101 Prince Philip Drive
Olney, MD 20832

301-774-8800 (Evaluation Center)
301-774-8888 (Crisis Intervention)

Provide inpatient and outpatient treatment for psychiatric and addiction treatment for those 13 and older.

**Washington DC Mental Health Helpline**
The DMH Access HelpLine is staffed by telephone counselors 24 hours a day, seven days a week, to help people of all ages.
1 (888) 793-4357 (7WE-HELP) for Mental Health Services

**Suicide National Hotline**
**USA National Suicide Hotlines**
Toll-Free / 24 hours / 7 days a week
1-800-SUICIDE 1-800-273-TALK
1-800-273-8255 1-800-784-2433
http://www.suicidepreventionlifeline.org/
http://suicidehotlines.com/national.html
TTY: 1-800-799-4TTY (4889)

**Weight Management and Food Support Resources**
**Overeaters Anonymous**
Website: http://www.oa.org/
Telephone: (505) 891-2664
Meeting Schedules: http://www.oa.org/meetings/find-a-meeting.php

**Food Addicts Anonymous**
Website: http://www.foodaddictsanonymous.org/
Telephone: (561) 967-3871
Email: faawso@bellsouth.net
Meeting Schedules: http://www.foodaddictsanonymous.org/meetings-events

**Food Addicts in Recovery Anonymous**
Website: http://www.foodaddicts.org/
Telephone: (781) 932-6300
E-Mail: office@foodaddicts.org
Meeting Schedules: http://foodaddicts.org/meetings.php

**Center for Eating Disorders at Sheppard Pratt**
Provides comprehensive treatment for individuals experiencing an eating disorder; Includes an inpatient unit, 12-hour day treatment program, daily intensive outpatient program, outpatient services, support groups, family, individual and group therapy; Many insurances and medical assistance accepted; No fee for support groups.
eatingdisorderinfo@sheppardpratt.org
www.eatingdisorder.org
410-938-5252
6535 North Charles Street, Suite 300
Baltimore, MD 21204

**Eating Disorders Institute of Maryland**
410-255-9626
1831-1 F Forest Drive
Annapolis, MD 21403

**John Hopkins Eating Disorder Program**
lryan@jhmi.edu

410-955-3863
600 N. Wolfe Street, Meyer 101
Baltimore, MD 21287

**National Association of Anorexia Nervosa & Associated Disorders**
Anorexia, Bulimia & Compulsive Overeating hotline, counseling, national network of free support . All services are free of charge.
847-831-3438
Hotline hours: Monday-Friday, 9:00 am-5:00 pm Central time

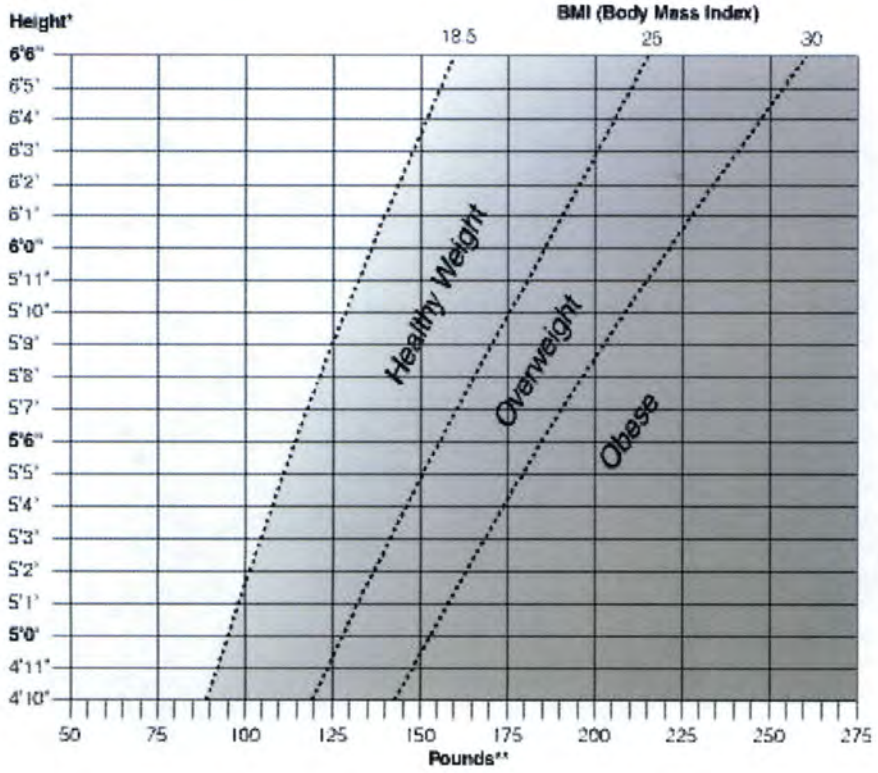
**National Eating Disorders Association**
Referrals to treatment options or support groups
1-800-931-2237
Live Helpline Hours: Monday- Friday: 8:30 am - 4:30 pm Pacific time

**Body Mass Index**

BMI indicates a person's weight status, relative to all other individuals. BMI uses height and weight to classify a person into one of several categories of weight status (e.g., normal-weight, overweight, obese). While "obesity" specifically refers to an excess amount of body fat, BMI does not show the amount of excess fat a person has. Despite this, BMI is important because it is predictive of many diseases and health problems. The BMI also allows us to judge the nutritional status of an individual. A BMI of less than 18.5 is considered to denote undernutrition.

Recently, it has been shown that BMI and Waist-Hip Ratio (WHR) together are better in predicting risk for many serious weight-related disorders (such as diabetes, high blood pressure, lipid disorders, high blood pressure, cardiovascular events) than either measure alone.

$$\text{BMI} = \left\{\frac{\text{WEIGHT (pounds)}}{\text{HEIGHT (inches)}^2}\right\} \times 703$$




| | NORMAL | | | | | | OVERWEIGHT | | | | | OBESE | | | | | | | | | | EXTREME OBESITY | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **BMI** | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 |
| **Height** (feet-inches) | **Weight** (Pounds) | | | | | | | | | | | | | | | | | | | | | | | |
| 4'10" | 91 | 96 | 100 | 105 | 110 | 115 | 119 | 124 | 129 | 134 | 138 | 143 | 148 | 153 | 158 | 162 | 167 | 172 | 177 | 181 | 186 | 191 | 196 | 201 |
| 4'11" | 94 | 99 | 104 | 109 | 114 | 119 | 124 | 128 | 133 | 138 | 143 | 148 | 153 | 158 | 163 | 168 | 173 | 178 | 183 | 188 | 193 | 198 | 203 | 208 |
| 5'00" | 97 | 102 | 107 | 112 | 118 | 123 | 128 | 133 | 138 | 143 | 148 | 153 | 158 | 163 | 168 | 174 | 179 | 184 | 189 | 194 | 199 | 204 | 209 | 215 |
| 5'01" | 100 | 106 | 111 | 116 | 122 | 127 | 132 | 137 | 143 | 148 | 153 | 158 | 164 | 169 | 174 | 180 | 185 | 190 | 195 | 201 | 206 | 211 | 217 | 222 |
| 5'02" | 104 | 109 | 115 | 120 | 126 | 131 | 136 | 142 | 147 | 153 | 158 | 164 | 169 | 175 | 180 | 186 | 191 | 196 | 202 | 207 | 213 | 218 | 224 | 229 |
| 5'03" | 107 | 112 | 118 | 124 | 130 | 135 | 141 | 146 | 152 | 158 | 163 | 169 | 174 | 180 | 186 | 191 | 197 | 203 | 208 | 214 | 220 | 225 | 231 | 237 |
| 5'04" | 110 | 116 | 122 | 128 | 134 | 140 | 145 | 151 | 157 | 163 | 169 | 175 | 180 | 186 | 191 | 197 | 204 | 209 | 215 | 221 | 227 | 232 | 238 | 244 |
| 5'05" | 114 | 120 | 126 | 132 | 138 | 144 | 150 | 156 | 162 | 168 | 174 | 180 | 186 | 192 | 198 | 204 | 210 | 216 | 222 | 228 | 234 | 240 | 246 | 252 |
| 5'06" | 118 | 124 | 130 | 136 | 142 | 148 | 155 | 161 | 167 | 173 | 179 | 186 | 192 | 198 | 204 | 210 | 216 | 223 | 229 | 235 | 241 | 247 | 253 | 260 |
| 5'07" | 121 | 127 | 134 | 140 | 146 | 153 | 159 | 166 | 172 | 178 | 185 | 191 | 198 | 204 | 211 | 217 | 223 | 230 | 236 | 242 | 249 | 255 | 261 | 268 |
| 5'08" | 125 | 131 | 138 | 144 | 151 | 158 | 164 | 171 | 177 | 184 | 190 | 197 | 204 | 210 | 216 | 223 | 230 | 236 | 243 | 249 | 256 | 262 | 269 | 276 |
| 5'09" | 128 | 135 | 142 | 149 | 155 | 162 | 169 | 176 | 182 | 189 | 196 | 203 | 210 | 216 | 223 | 230 | 236 | 243 | 250 | 257 | 263 | 270 | 277 | 284 |
| 5'10" | 132 | 139 | 146 | 153 | 160 | 167 | 174 | 181 | 188 | 195 | 202 | 209 | 216 | 222 | 229 | 236 | 243 | 250 | 257 | 264 | 271 | 278 | 285 | 292 |
| 5'11" | 136 | 143 | 150 | 157 | 165 | 172 | 179 | 186 | 193 | 200 | 208 | 215 | 222 | 229 | 236 | 243 | 250 | 257 | 265 | 272 | 279 | 286 | 293 | 301 |
| 6'00" | 140 | 147 | 154 | 162 | 169 | 177 | 184 | 191 | 199 | 206 | 213 | 221 | 228 | 235 | 242 | 250 | 258 | 265 | 272 | 279 | 287 | 294 | 302 | 309 |
| 6'01" | 144 | 151 | 159 | 166 | 174 | 182 | 189 | 197 | 204 | 212 | 219 | 227 | 235 | 242 | 250 | 257 | 265 | 275 | 280 | 288 | 295 | 302 | 310 | 318 |
| 6'02" | 148 | 155 | 163 | 171 | 179 | 186 | 194 | 202 | 210 | 218 | 225 | 233 | 241 | 249 | 256 | 264 | 272 | 280 | 287 | 295 | 303 | 311 | 319 | 326 |
| 6'03" | 152 | 160 | 168 | 176 | 184 | 192 | 200 | 208 | 216 | 224 | 232 | 240 | 248 | 256 | 264 | 272 | 279 | 287 | 295 | 303 | 311 | 319 | 327 | 335 |
| 6'04" | 156 | 164 | 172 | 180 | 189 | 197 | 205 | 213 | 221 | 230 | 238 | 246 | 254 | 263 | 271 | 279 | 287 | 295 | 304 | 312 | 320 | 328 | 336 | 344 |

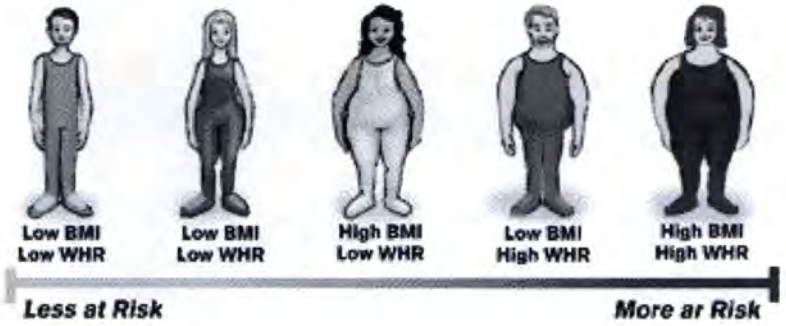
Adapted from: George Bray, Pennington Biomedical Research Center; *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: The Evidence Report*, National Institutes of Health, National Heart, Lung, and Blood Institute, September 1998.

**Body Fat Distribution: "Pears" vs. "Apples" and the Reason for Waist to Hip Measurements**

The pattern of body fat distribution is an important predictor of the health risks of obesity.

Carrying fat primarily around your waist, or being "apple-shaped", puts you at much greater risk of developing obesity-related health problems such as hypertension, heart disease, or diabetes than people who weigh the same as you but carry their weight in the hips and buttocks ("pear" shape). The most practical way to determine whether you have too much abdominal fat is to measure your waist circumference:

Women with a waist measurement of 35 inches or more (or men with a waist measurement of 40 inches or more) have a higher health risk because of how their body fat is distributed. Waist circumference above 39 inches (100cm), regardless of gender, is a strong risk factor for insulin resistance. Insulin resistance is a key player in metabolic syndrome and the precursor to type 2 diabetes.



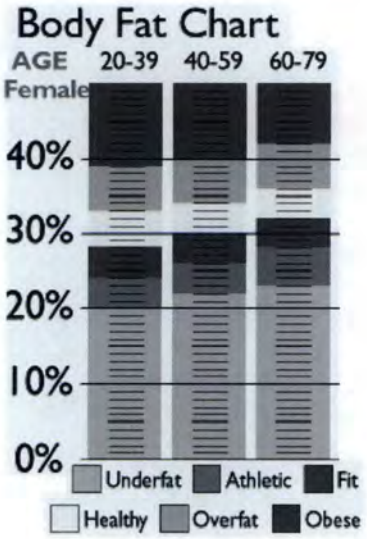

| | Women (Waist Circumference) | |
|---|---|---|
| **Risk** | **cm** | **inches** |
| Very High | > 110 | > 43.5 |
| High | 90 - 109 | 35.5 - 43 |
| Low | 70 - 89 | 28.5 - 35 |
| Very Low | < 70 | < 28.5 |

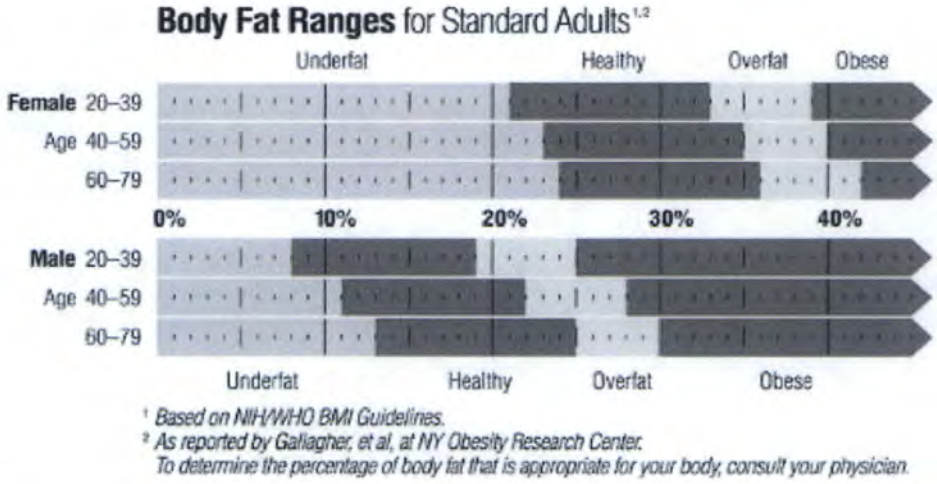
**The Waist to Hip Ratio table gives general guidelines for acceptable levels for hip to waist ratio.**

| | acceptable | | unacceptable | | |
|---|---|---|---|---|---|
| | **excellent** | **good** | **average** | **high** | **extreme** |
| **male** | **< 0.85** | **0.85 - 0.90** | **0.90 - 0.95** | **0.95 - 1.00** | **> 1.00** |
| **female** | **< 0.75** | **0.75 - 0.80** | **0.80 - 0.85** | **0.85 - 0.90** | **> 0.90** |

**Body Fat Percentage**

Everyone needs a certain amount of body fat. Aside from providing stored energy for the body when food is scarce, body fat insulates the body and provides protection against cold, supports the spinal cord and major organs, and helps metabolize numerous vitamins. Ideal body fat percentage varies from person to person but the average male is recommended to maintain a body fat percentage between 11 to 24%. A healthy body fat range for the average woman is around 23 to 33%. These percentages vary slightly with age but are generally applicable for adults aged 20-80.



**Appendix C: Phone Screen and Telephone Script**

Script for Phone Screen

"Hello, my name is _____. I am calling you back regarding the appetite and attention study. Do you have about 30 minutes to go through the screening process right now?"

**If no**: "When is a good time to call you back?"
**If yes**: *continue with phone screen*

"I'd like to give you some information about the study and then I'll be glad to answer any questions that you might have, OK? This study is designed to compare women who are non-overweight and women who are obese using national cutoffs for body mass index. We use height and weight to calculate BMI and determine which group you will be in. We are interested in understanding how body weight and appetite affect cognitive performance on computer tests. We are also testing to see how performance can be modified with training.

If you are eligible and agree to participate, you will be assigned to a training or no-training condition that may include taste testing snack food and healthy food items. In either group, you will be asked to fill out several questionnaires and you will be asked to complete some simple tests of attention on the computer. We will only meet once and this meeting should last about 2 and a half to 3 hours and will take place in Bethesda across the street from the National Institutes of Health at the Uniformed Services University. You will be asked to eat your normal lunchtime meal within one hour of arriving at the university for your study appointment so that you are <u>not at all hungry</u> when we begin testing. You will be asked to record everything that you eat on the day of your study appointment. This includes the timing of your meals on the day that you come to the university, what and how much you eat for breakfast and lunch on the day of your study appointment, and the time you had dinner the evening before.

If you meet all of the screening criteria for the study and decide you would like to participate, it is your right as a participant in a research study to withdraw at any time for any reason if you no longer wish to continue. *[You may leave at any time without consequence. Your participation in this study is entirely voluntary. It is also your right as a research participant to cancel your study appointment at any time for any reason. We understand that participating in a research study is an investment of your time and we greatly appreciate it. One of our priorities is minimizing participant burden so should you choose to participate we will provide study contact information in the event that you choose to reschedule or cancel your appointment at any time.]*

This study is being run by a senior graduate student who has a Master's Degree in Medical Psychology and has over 8 years of experience conducting research studies.

If you complete all of this, you will be paid $50 by check in the mail about 3-5 weeks after you complete the study. Since we need all of the information requested in order to use your data, you will have to complete all parts of the study before you can be compensated.

Does this sound like something you would be interested in?

**If no**: "Thank you for your interest."

**If yes**: "Do you have any questions about the study?

Ok, now I will ask you some questions to see if you meet eligibility criteria for the study."

COMPLETE PHONE SCREEN.

**If the caller does not meet requirements**: "I am sorry, but you do not meet the requirements for this study. This doesn't mean that there is something wrong with you, it simply means that we are looking at very specific things. It is very important for research purposes that our groups look as similar to each other as possible.

Thank you for your interest."

**If caller meets requirement:** "Do you have any questions?"

"I am pleased to inform you that you meet the requirements for this study. We can schedule your appointment now."

"May I get your email address so that I can email you directions? (Collect pertinent contact information). Thank you in advance for your participation."

**Provide caller USUHS parking information:**

You can park in the school's underground parking garage for free. Due to heightened security, you must bring a picture ID with you in order to get on base. We will also need to add your name to the visitors list. When you arrive, simply show the guard at the gate your ID and state your name.

**PHONE SCREEN**

Interviewer: _____
Potential Participant:
Date:_____

1. Are you in the military? YES NO
   *If yes → Inform the individual that "military personnel cannot be financially compensated for participation unless you are in non-working (leave) status. If you are active duty and are in non-working status during the course of this study we will give you a form to complete so that you can be compensated. If you do not wish to be compensated this form does not apply"*

   A. (If in the military) Are you still interested in participating? YES NO
      *If yes → continue with phone screen.*
      *If no → "Thank you for your time. Have a nice day."*

2. How did you hear about the study?_____

3. Age_____

4. Height_____ inches

   BMI = _____

5. Weight_____ pounds

   A. When/where was the last time you weighed yourself? _____

6. Do you use tobacco? YES NO

   A. Do you use marijuana? YES NO
   B. Do you use any other recreational or illegal substances? YES NO
      *If yes → exclude from study*

7. FOOD ALLERGIES:

   A. Do you have any food allergies? YES NO
      If yes → what foods are you allergic to? _____

   B. Are you lactose intolerant? YES NO
      If YES → Can you eat chocolate? YES NO
      *If NO → exclude from study*

   C. Do you have an allergy to nuts or seeds? YES NO
      *If YES → exclude from study*

8. TASTE TEST: "Now I am going to ask you whether you like to eat some different foods."

| | | |
|---|---|---|
| A. Do you like potato chips? | YES | NO |
| B. Do you like mixed nuts? | YES | NO |
| C. Do you like apple slices? | YES | NO |
| D. Do you like rice cakes? | YES | NO |
| E. Do you like pretzels? | YES | NO |
| F. Do you like milk chocolate? | YES | NO |
| G. Do you like yogurt? | YES | NO |
| H. Do you like baby carrots? | YES | NO |
| I. Do you like chocolate chip cookies? | YES | NO |
| J. Do you like granola bars? | YES | NO |
| K. Do you like air-popped popcorn? | YES | NO |

*If NO to any of A-J, ask if the participant would be willing to eat a small amount for a taste test. If NO to **A, F, H, K** → exclude from study*

9. Have you been told by a physician that you had:

| | | |
|---|---|---|
| A. Hypertension | YES | NO |
| If yes → is your hypertension controlled? | YES | NO |
| *If no → exclude from study* | | |
| B. High Blood Sugar/Diabetes | YES | NO |
| C. Thyroid Disease | YES | NO |

*If yes to **B or C** exclude from study.*

10. Have you been told by a psychiatrist or psychologist that you have or had:

| | | |
|---|---|---|
| A. Major Depression | YES | NO |

If yes → how long ago? _____

If yes → are you currently getting treatment or taking prescription or over-the-counter medications for depression? YES NO

*If yes → exclude from study.*

| | | |
|---|---|---|
| B. Anxiety Disorder | YES | NO |
| C. Schizophrenia/Personality Disorder | YES | NO |
| D. Bipolar Disorder | YES | NO |
| E. Substance Dependence | YES | NO |
| F. Any type of Eating Disorder | YES | NO |

If yes, what was the diagnosis? _____

*If yes to **B, C, D, E, or F** exclude from study.*

11. Are you currently taking any prescription or over-the-counter medications or supplements?

YES NO

If yes, what are you taking?

1. _____ 4. _____
2. _____ 5. _____
3. _____ 6. _____

*If YES, please refer to list of exclusion medications (prescription, OTC). If current medications are on the list → exclude from study. If medications are not on the list but are questionable refer phone screen to PI for eligibility determination.*

12. Are you taking any medications or supplements for weight loss? YES NO
    *If YES → exclude from study*

13. Are you currently pregnant or nursing? YES NO
    *If yes → exclude from study*

14. FOOD INTAKE:

A. Are you currently participating in any sort of diet regimen that restricts what you are allowed to eat? YES NO
*If yes → exclude from study*

B. Do you have a condition or take any medications that dictate how often or what you should eat? YES NO
*If yes → exclude from study*

C. In the last month, how many meals did you eat per day, on average? _____

D. How many days per week do you eat breakfast? _____

D1. What time of the day do you usually eat breakfast? _____

E. How many days per week do you eat lunch? _____
E1. What time of the day do you usually eat lunch? _____

F. How many days per week do you eat dinner? _____
F1. What time of the day do you usually eat dinner? _____

G. Do you eat a different number of meals on the weekends (Saturday, Sunday) than you do during the week (Monday-Friday)? YES NO
G1. Do you eat a different amount of food on the weekends than you do during the week YES NO

G2. Do you find that you skip meals on the weekends YES NO

If yes, which meal(s) do you commonly skip? _____

_____

G3. Compared to the meals you eat for lunch during the week, do your lunches on the weekend generally consist of: **More Food** **Less Food** or **about the same amount of Food** as your lunches during the week (circle one).

**If weekday and weekend lunchtime intake differ or lunch is skipped on weekends, try NOT to schedule the individual for a weekend study visit.*

**If the caller does not meet requirements, READ**: "I am sorry, but you do not meet the requirements for this study. This doesn't mean that there is something wrong with you, it simply means that we are looking at very specific things. It is very important for research purposes that our groups look as similar to each other as possible. If it is alright with you, I will take your contact information and stay in touch in case the study requirements change or in case other research studies become available."

**If caller would like to provide contact information:** proceed to next page and obtain info.

**If eligible to participate, READ:** *"Great. Thank you for your interest in the study and for answering the screening questions. From what I see it looks like you meet criteria for the study, however, I will have our study leader review your answers and we will contact you if we have any additional questions. Can I get your contact information?"*

Name: _____

Address: _____

_____

Cell Phone: _____ Home Phone: _____

Work Phone: _____ Ext: _____

E-mail: _____

Preferred Method of Contact:

□ Email □ Cell Phone □ Mail □ Home Phone □ Work Phone

***Read:*** *"Based on the information that you gave me, I would like to schedule your study appointment for (weekday / weekend)* (circle one). *One of the things that we are interested in studying is appetite so it is important that you arrive at the lab to begin the study within ONE hour after you have eaten lunch. You may bring your lunch with you and eat it at the university or purchase lunch at the cafeteria before you begin the study if you would like. We will also ask you to record what you eat for breakfast and for lunch on the day of your study appointment using a food recording sheet that will be emailed to you. The entire study takes about 3 hours to complete. Is there a day that you are free after lunch for this amount of time?"*

Date/Time of Scheduled Study Visit: _____

_____

_____

***Read:*** *"Okay. We will contact you to confirm the date that you are coming to USUHS and to make sure that you have directions to our lab and a copy of the food recording log you will use to record your food intake on (DATE scheduled for study visit). You can park in the school's underground parking garage for free. Because the school is on the National Naval Medical Center base, you must bring a picture ID with you in order to get on base and your name will be on a visitors list for (DATE scheduled for study visit). When you arrive at the gate, simply show the guard your ID and state your name. If there are any problems someone from the lab will come out to the gate to escort you onto base.* Do you have any questions?"

**Remember to Update Phone Screening Call Log when finished***

Notes (e.g., driving/metro/@ USU; buying/bringing lunch etc.) : _____

_____

_____

**Appendix D: Informed Consent form**

*Consent for Participation in a Research Study*

**Title of Project:** Attention to Health-Related Pictorial Cues

**Principal Investigator: Elena A. Spieker, M.S.**

## INTRODUCTION

The following information is provided to inform you about the research project and your participation in it. Please read this form carefully and feel free to ask any questions you may have about this study and/or about the information given below.

It is important that you understand that your participation in this study is entirely voluntary. **You may refuse to participate or choose to withdraw from this study at any time**. If, during the course of the study, you should have any questions about the study or your participation in it, you may contact:

**Elena Spieker, M.S. at 410-575-4009**
Department of Medical & Clinical Psychology, USUHS, Bethesda, MD 20814-4799

**Tracy Sbrocco, Ph.D. at 301-295-9674**
Department of Medical & Clinical Psychology, USUHS, Bethesda, MD 20814-4799

**Office of Research at (301) 295-3303**
USUHS, Bethesda, Maryland 20814

## 1. THE PURPOSE OF THIS STUDY:

Overweight and obesity form the basis of the second leading cause of preventable death in the United States. Although behavioral interventions are successful in short term weight loss, maintaining lost weight is still challenging. A major challenge to weight management is images in the environment that encourage eating even though we are not hungry.

The purpose of the proposed research project is to better understand how body weight and appetite affect cognitive performance on computer tests. We are also testing to see how performance can be modified with training. We are evaluating how different people respond to images of food after they have eaten a meal. You will be one of 80 to 120 female volunteers from the Washington DC and surrounding areas asked to participate in

this study. We are studying several factors that affect how females view food, how seeing food affects appetite, and whether the effect of viewing food when we are not hungry can be modified.

This project is being done solely for the purpose of research with the goal of contributing to existing knowledge about the impact of the "food environment." Research studies have many steps and are done to answer questions that have not yet been answered about the world around us. The study you are participating in consists of several procedures that everyone in the study will be asked to complete.

Research designs often require that the full intent of the study not be explained prior to participation. Although we have described the general nature of the tasks that you will be asked to perform, the full intent of the study will not be explained to you until after the completion of the study. At that time, we will provide you with a full debriefing which will include an explanation of the hypothesis that was tested and other relevant background information pertaining to the study. You will also be given an opportunity to ask any questions you might have about the procedures used in the study.

**2. THE PROCEDURES TO BE FOLLOWED:**
If you agree to participate in this study, you will be asked to fill out a series of questionnaires, perform some computer tests of attention, and taste test several different foods. Your weight, height, body fat, waist, and hip circumference will be taken. The information from these assessments will be provided and explained to you. As part of this study, you will be asked to record your food intake the morning of your study visit and the time of the meal you ate the evening before. You will also be asked a number of questions about your health to make sure that you are eligible to participate in this study.

Individuals meeting a certain weight range and meeting other criteria (see inclusion and exclusion criteria listed below) are eligible to participate in the study. If you meet weight and other criteria listed below you will be asked to participate in the study procedures outlined below.

Inclusion criteria:
- Adult female between the ages of 18-60 years
- Body mass index (BMI) > 18.5 $kg/m^2$
- No major medical conditions that influence body weight (such as diabetes, thyroid disease)
- Non-smoking

Exclusion criteria:

- History of thyroid disease
- Diabetes
- Current tobacco use
- Pregnancy or lactation

- History of anxiety disorder, personality disorder, substance dependence, schizophrenia, eating disorder
- Untreated major depression
- Uncontrolled hypertension
- Current use of medications or over-the-counter supplements that affect body weight or eating behavior
- Dislike of or food allergies to chocolate or peanuts/lactose intolerance

Participation in this study includes a 30 minute phone screen used to determine if you are eligible to participate in the study and a single 2 and a half hour visit that takes place at the Uniformed Services University in Bethesda, MD. The summary of the study procedures can be found below.

| Step | Study Procedure | Time Required |
|---|---|---|
| Visit to University | 1. Study description and Informed Consent Form (15 min)<br>2. Height, weight, and body composition (5 min)<br>3. Baseline questionnaires (20 min)<br>4. Tests of attention and performance training (80 min)<br>5. Taste test (15 min)<br>6. Debriefing, check-out questionnaire, and payment (15 min) | 150 minutes |
| | **Total Time:** | **2 ½ hours** |

Below are brief descriptions of all study procedures, including the risks and benefits.

***Body Measurements***

Your body weight, height, and body composition will be measured at the beginning of the visit. Your body fat will be estimated at the beginning of the study by bioelectric impedance analysis (BIA). BIA is a method of determining body fat by measuring how a very small amount of electricity passes through the body. BIA is measured using a scale that has special recording pads. You will be asked to remove your shoes and socks when you are weighed on the scale. This allows your body fat percentage to be measured. You will not feel the current that is passed through you, and there is no discomfort or risk associated with BIA measurement. We will also measure central distribution of body fat by using an inelastic measuring tape around the waist and hip.

***Interviews and Questionnaires***

You will be asked to complete psychological questionnaires designed to gather information relating to your eating and health habits, your life and medical history, and overall well being. It will take approximately 20 minutes to complete these questionnaires. When filling out the questionnaires you may skip any questions you do not wish to answer. All questionnaires will be scored after completing the study; they will also be coded so that you are not personally identified on the questionnaire.

During this visit we will ask you to complete computer tests that will be used to assess reaction times and attention. You will be asked to complete the computer tests more than once. Each computer test lasts approximately 6-8 minutes. Not everyone in this study will complete the same computer tests and we are looking at differences between people who complete the different computer tests. After you complete all of the computer tests, you will be asked to taste and rate some food. If you have an allergy to any food or dislike specific foods please inform the study staff.

**3. DURATION OF THE STUDY**

The total time you will spend participating is approximately 2.5 to 3 hours.

**4. POSSIBLE DISCOMFORTS AND/OR RISKS FROM PARTICIPATING IN THIS STUDY:**

a. There are no known risks associated with participating in this study. There may be questions you are asked to answer that make you uncomfortable. You will NOT be forced to do anything you do not want to do. You may feel free to skip questions at any time. Also, you may decline to participate at any time and/or withdraw your participation at any time.

b. You may experience frustration or boredom during the computer tests. You have the option of taking a break between tests or you may discontinue participation at ANY time without consequence.

c. During this study you will be asked to taste a small amount of food. Although the foods have been chosen because they are generally considered good tasting, you may not like the foods chosen. In the event that you do not like the foods you are asked to eat, you have the right to refuse to eat the food. Also, if you are currently dieting, you may experience guilt related to eating the food chosen for you. Because the amount you are asked to eat is relatively small, it is not expected that you will experience any sort of extreme reaction to eating, however you do have the right to refuse to eat the food if you feel that it would cause you to experience negative emotions.

**5. POSSIBLE BENEFITS TO YOU FROM PARTICIPATING IN THIS STUDY:**

You may gain a better understanding of your eating behavior and your body composition, specifically your body fat percentage and your waist and hip circumference, which are indicators of disease risk. The testing is conducted at no charge and you will be provided with the results of your body composition assessment. Through completing this study, you will be providing information that will be helpful in expanding scientific knowledge about attention and eating behavior. The results of this study will help us gain a better understanding of how attention can be modified with computer tests and how these factors may relate to overweight and obesity. Our ultimate long term goal is to gain a better understanding of what factors are associated with overeating and successful long-term weight loss and/or maintenance.

## 6. ALTERNATE PROCEDURES:

Your alternative to participating in this study is not to participate in this study. There is no consequence to choosing not to participate.

## 7. PRIVACY AND CONFIDENTIALITY:

All information you provide as part of this study will be confidential and will be protected to the fullest extent provided by law. Information that you provide and other records related to this study will be accessible to those persons directly involved in conducting this study and members of the Uniformed Services University of the Health Sciences Institutional Review Board (IRB), which provides oversight for protection of human research volunteers. All questionnaires, forms and charts will be kept in a restricted access, locked cabinet while not in use. To enhance the privacy of the answers you provide, data from questionnaires will be entered into a database in which individual responses are not identified. After verification of the database information, paper copies of the questionnaires containing identifiers will be shredded. If you are a military member, please be advised that under Federal Law, a military member's confidentiality cannot be strictly guaranteed.

**Note: YOU ARE FREE TO WITHDRAW THIS CONSENT AND TO STOP PARTICIPATING IN THIS STUDY AT ANY TIME FOR ANY REASON.**

If you choose to withdraw your consent and stop participating you will be given the choice whether or not you wish to withdraw any data that you have provided up to that point. There is no consequence to withdrawing your consent or your data from the study at any time.

## 8. COMPENSATION

The testing is conducted at no charge. You will be paid $50 for completing this study. Since we need all of the information requested in order to use your data, you will have to complete all parts of the study before you will be paid.

**Military:**
Military personnel cannot be financially compensated for participation unless you are in non-working (leave) status. If you are active duty military and wish to be compensated for your participation because you are in non-working status during the course of this study, you must complete the form "Statement of Approval for Participation in Research" given to you by the study staff. If you do not wish to be compensated this form does not apply, but you are strongly encouraged to inform your command of your participation.

## 9. RECOURSE IN THE EVENT OF INJURY:

This study should not entail any physical or mental risk beyond those described above. We do not expect complications to occur, but if, for any reason, you feel that continuing

this study would constitute a hardship for you, we will end your participation in the study.

In the event of a medical emergency while participating in this study or medical treatment required as a result of your participation in this study, you may receive emergency treatment in the facility you are in or a nearby Department of Defense (military) medical facility (hospital or clinic). Treatment/care will be provided even if you are not eligible to receive such care. Care will be continued until the medical doctor treating you decides that you are out of immediate danger. If you are not entitled to care in a military facility, you may be transferred to a private civilian hospital. The attending doctor or member of the hospital staff will go over the transfer decision with you before it happens. The military will bill your health insurance for health care you receive which is not part of the study. You will not be personally billed and you WILL NOT be expected to pay for medical care at our hospitals. If you are required to pay a deductible you may make a claim for reimbursement through the Uniformed Services University Office of General Counsel.

In case you need additional care following discharge from the military hospital or clinic, a military health care professional will decide whether your need for care is directly related to being in the study. If your need for care is related to the study, the military may offer you limited health care at its medical facilities. This additional care is not automatic.

If at any time you believe you have suffered an injury or illness as a result of participating in this research project, you should contact the Office of Research at the Uniformed Services University of the Health Sciences, Bethesda, Maryland 20814-4799 at (301) 295-3303. This office can review the matter with you, can provide information about your rights as a subject, and may be able to identify resources available to you. If you believe the government or one of the government's employees (such as a military doctor) has injured you, a claim for damages (money) against the federal government (including the military) may be filed under the Federal Torts Claims Act. Information about judicial avenues of compensation is available from the University's General Counsel at (301) 295-3028.

Should you have any questions at any time about the study you may contact the principal investigator, **Elena A. Spieker, M.S., Department of Medical & Clinical Psychology, USUHS, Bethesda, MD 20814-4799, at 410-575-4009.** If you have questions about your rights as a research subject, you should call the Director of Human Research Protections Programs at USUHS at (301) 295-9534. She is your representative and has no connection to the researcher conducting this study.

**STATEMENT BY PERSON AGREEING TO PARTICIPATE IN THIS RESEARCH PROJECT:**

**I have read this consent form and I understand the procedures to be used in this study and the possible risks, inconveniences, and/or discomforts that may be involved. All of my questions have been answered. I freely and voluntarily choose to participate. I understand I may withdraw at any time. My signature also indicates that I have received a copy of this consent form for my information.**

**SIGNATURES:**

| | |
|---|---|
| _____ | _____ |
| **Signature of Witness** | **Signature of Volunteer** |
| _____ | _____ |
| **Witness Name (Printed)** | **Volunteer Name (Printed)** |
| **Date**_____ | **Date**_____ |

*I certify that I or my research staff have explained the research study to the above individual, and that the individual understands the nature and purpose, the possible risks and benefits associated with taking part in this research study. Any questions that have been raised have been answered.*

**Investigator's or Designee's Signature** _____

**Printed Name** _____

**Appendix E: Anthropometric Measurement Form**

Measurements taken on (date) _____ by (initials) _____

Age (years): _____

Height (inches): _____

Weight (lbs): _____

Body Mass Index ($kg/m^2$): _____

Body Fat Percentage (%): _____

Waist circumference (inches): _____

Hip circumference (inches): _____

Waist-to-hip ratio (Waist/Hip): _____

Notes: _____

_____

_____

_____

**Appendix F: Self-Report Questionnaires**

Demographics and Medical History Questionnaire

Eating Inventory (Stunkard & Messick, 1985)

Eating in the Absence of Hunger (Tanofsky-Kraff et al., 2008)

Eating Disorder Diagnostic Scale (EDDS) (Stice, Telch, & Rizvi, 2000)

Yale Food Addiction Scale (YFAS) (Gearhardt, Corbin & Brownell, 2009)

Food Craving Inventory (FCI) (White et al., 2001)

Visual Analog Scales: (designed for current study)

- Food Rating – Baseline
- Food Rating – Taste Test
- Hunger, Fullness, and Craving Rating Sheet
-

Picture Stimulus Rating Instructions (designed for current study)

Check Out Questionnaire (designed for current study)

**Demographics and Medical History Questionnaire**
The following questions ask you to give some background information about yourself. This information will help us to understand and interpret the study's results. The information will be kept completely confidential. Please answer the best question. If you feel more than one answer describes you, please choose the most accurate on how you would define yourself.

**Demographics**

**1.** Date of Birth _____
**2.** Age _____
**3.** Height _____
**4.** Weight _____

**5.** What is your employment status? (please check one)

_____ Full-time
_____ Part-time
_____ Retired
_____ Currently not employed
_____ Other _____

Occupation _____

**6.** What is your relationship status? (please check one)

_____ Married
_____ Separated
_____ Divorced
_____ Widowed
_____ Single, Never Married
_____ Living together, Not married

Have you had any relationship status changes in the past 12 months? ☐ No ☐ Yes
If so, please describe _____

**7.** How would you classify your ethnicity? (please check one or more)

_____ Caucasian
_____ Black or African American, Non-Hispanic
_____ African
_____ West Indian or Caribbean
_____ Hispanic or Latino
_____ Asian
_____ American Indian
_____ Native Hawaiian or other Pacific Islander
_____ Alaskan Native
_____ Other _____

**8.** What is the highest grade or class you completed in school? (please check one)

_____ Less than 12th grade
_____ High school graduate or GED
_____ Some college
_____ Associates degree, community college, or technical college
_____ Bachelor's degree or nursing degree
_____ Master's degree or R.N.
_____ Doctorate (Ph.D., Ed.D., etc) or Medical degree (M.D.)

**9.** What is your household income before taxes? (please check one)

_____ Under $20,000
_____ $20,000-29,999
_____ $30,000-39,999
_____ $40,000-49,999
_____ $50,000-59,999
_____ $60,000-69,999
_____ Above $70,000

**10.** How many people live in your household including yourself? _____

**11.** What is your religious preference?

_____ Jewish
_____ Protestant Christian
_____ Catholic
_____ Muslim
_____ Hindu
_____ Other _____

**Personal Medical & Psychiatric History**

**1.** Do you receive regular medical care from a physician or clinic? ☐ No ☐ Yes

**2.** Have you ever been told you had or currently have any of the following medical conditions?

| | Yes | No | Don't know | Year | Past/current treatment(s) |
|---|---|---|---|---|---|
| Heart Disease | | | | | |
| High Blood Pressure | | | | | |
| Diabetes or High Blood Sugar | | | | | |
| Cancer | | | | | |
| Thyroid Disease | | | | | |
| Stroke | | | | | |
| Gout | | | | | |
| High Cholesterol | | | | | |
| Hormone Problem | | | | | |
| Asthma | | | | | |
| Tuberculosis | | | | | |
| Kidney Disease | | | | | |
| Peptic Ulcers | | | | | |
| Gall Bladder Problems | | | | | |
| Spinal cord, neck or head injury | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Back problem | | | | | |
| Alcoholism | | | | | |
| Drug Addiction | | | | | |
| Depression | | | | | |
| Eating Disorder | | | | | |
| Anxiety or Stress | | | | | |

**3.** Have you had any other disease? ☐ No ☐ Yes
If so, what _____

**4.** Have you ever received any previous psychiatric or psychological evaluation or treatment? ☐ No ☐ Yes

If yes, complete the following:

| Year | Reason | Medication Used |
|---|---|---|
| _____ | _____ | |
| _____ | _____ | |
| _____ | _____ | |

**Review of Your Current Health**

1. Are you in the habit of using any of the following?

| | Amount Currently Using | Most Ever Used | When did you stop using, if ever? |
|---|---|---|---|
| Coffee (cups/day) | | | |
| Cigarettes (packs/day) | | | |
| Alcohol | | | |
| Vitamins | | | |
| Sleeping Pills | | | |
| Aspirin | | | |
| Laxatives | | | |
| Diet Pills | | | |

**2.** Have you or do you currently use hormonal birth control? □ No □ Yes

If so, what kind?

_____ Oral contraceptive
_____ Patch
_____ Shot (Depo-Provera, etc.)
_____ Vaginal ring
_____ Hormone implants
_____Subcutaneous implant (Implanon)
_____ Other _____

**3.** How long have you been taking contraceptives? _____

**4.** How many times have you been pregnant? _____

**5.** How many children have you given birth to? _____

**6.** Have you or do you currently use hormone replacement therapy? □ No
□ Yes

**7.** When was your last menstrual cycle (in months)? _____

**8.** Are you currently menstruating? □ No
□ Yes

**9.** Are you currently taking any prescription medications or over-the-counter herbs/supplements? □ No □ Yes

If yes, please give name, purpose, and dosage

_____
_____
_____
_____
_____
_____

**Lifestyle Habits and Weight History Questions**

1. How much has your body weight fluctuated in the last year? _____
2. Is your current weight more, less, or the same as your weight 12 months ago?

**MORE THAN** **LESS THAN** **SAME**

If your weight has changed in the last 12 months, by how many pounds?_____

3. How do you perceive yourself, based on your weight?

**Healthy weight** **Overweight** **Obese** **Very Obese**

4. How many meals do you typically eat in one day? _____

5. How many snacks do you typically eat in one day? _____

6. How many hours of sleep do you typically get on a given night? _____

7. Do you smoke? _____ If Yes, how often? _____

8. How often do you exercise? _____

9. Overall, how would you rate your healthy habits:

**Excellent** **Good** **Average** **Below average** **Poor**

10. Overall, how would you rate your general health:

**Excellent** **Good** **Average** **Below average** **Poor**

11. Are you currently participating in any sort of diet regimen? **YES** **or** **NO**

If yes, please describe any restrictions to your diet:

_____

_____

12. Before arriving today, about how many hours ago did you eat something?

_____

13. Please describe what and how much you ate today: _____

_____

_____

_____

14. What time did you eat dinner last night? _____

15. Please describe what and how much you had for dinner last night: _____

_____

_____

_____

_____

**FOOD CHOICES QUESTIONS**

1) Do you ever eat when you are not hungry? **YES or NO**

**If YES, please indicate the main reasons that you eat when you are not hungry**

a)_____ Chocolate
b)_____ Cake, any kind
c)_____ Cookies, any kind
d)_____ Candy, sweet
e)_____ Candy, sour
f)_____ Ice Cream, any kind

**If YES, please indicate the foods you prefer when you eat but are not hungry. Please check all that apply.**

**Sweets**
a)_____ Chocolate
b)_____ Cake, any kind
c)_____ Cookies, any kind
d)_____ Candy, sweet
e)_____ Candy, sour
f)_____ Ice Cream, any kind

**Savory**
g)_____ Potato Chips
h)_____ French Fries
i)_____ Crackers
j)_____ Fried food, any kind
k)_____ Burgers
l)_____ Pizza

**Other**
m)_____ Alcohol, any kind
n) _____ Cigarettes

2) If you were unable to eat your preferred food during a stressful time, would you still eat something? **YES or NO**

3) Please write down any additional foods or drinks that you enjoy eating when you eat but are not hungry.

_____
_____
_____

# Eating Inventory

Subject ID | Subject Code

○ Pre ○ Mid ○ Post ○ 3M ○ 6M ○ 12M ○ 18M ○ 24M

**DIRECTIONS**: Please answer the following questions by filling in true or false.

1. When I smell a sizzling steak or see a juicy piece of meat, I find it very difficult to keep from eating, even if I have just finished a meal. ○ True ○ False
2. I usually eat too much at social occasions, like parties and picnics. ○ True ○ False
3. I am usually so hungry that I eat more than three times a day. ○ True ○ False
4. When I have eaten my quota of calories, I am usually good about not eating any more. ○ True ○ False
5. Dieting is so hard for me because I just get too hungry. ○ True ○ False
6. I deliberately take small helpings as a means of controlling my weight. ○ True ○ False
7. Sometimes things just taste so good that I keep on eating even when I am no longer hungry. ○ True ○ False
8. Since I am often hugry, I sometimes wish that while I am eating, an expert would tell me that I have had enough or that I can have something more to eat. ○ True ○ False
9. When I feel anxious, I find myself eating. ○ True ○ False
10. Life is too short to worry about dieting. ○ True ○ False
11. Since my weight goes up and down, I have gone on reducing diets more than once. ○ True ○ False
12. I often feel so hungry that I just have to eat something. ○ True ○ False
13. When I am with someone who is overeating, I usually overeat too. ○ True ○ False
14. I have a pretty good idea of the number of calories in common food. ○ True ○ False
15. Sometimes when I start eating, I just can't seem to stop. ○ True ○ False
16. It is not difficult for me to leave something on my plate. ○ True ○ False
17. At certain times of the day, I get hungry because I have gotten used to eating then. ○ True ○ False
18. While on a diet, if I eat food that is not allowed, I consciously eat less for a period of time to make up for it. ○ True ○ False
19. Being with someone who is eating often makes me hungry enough to eat also. ○ True ○ False
20. When I feel blue, I often overeat. ○ True ○ False
21. I enjoy eating too much to spoil it by counting calories or watching my weight. ○ True ○ False
22. When I see a real delicacy, I often get so hungry that I have to eat right away. ○ True ○ False
23. I often stop eating when I am not really full as a conscious means of limiting the amount that I eat. ○ True ○ False
24. I get so hungry that my stomach often seems like a bottomless pit. ○ True ○ False
25. My weight has hardly changed at all in the last ten years. ○ True ○ False
26. I am always hungry so it is hard for me to stop eating beore I finish the food on my plate. ○ True ○ False
27. When I feel lonely, I console myself by eating. ○ True ○ False
28. I consciously hold back at meals in order not to gain weight. ○ True ○ False
29. I sometimes get very hungry late in the evening or at night. ○ True ○ False
30. I eat anything I want, any time I want. ○ True ○ False
31. Without even thinking about it, I take a long time to eat. ○ True ○ False
32. I count calories as a conscious means of controlling my weight. ○ True ○ False
33. I do not eat some foods because they make me fat. ○ True ○ False

Subject ID

| | | | |
|---|---|---|---|
| | | | |



34. I am always hungry enough to eat at any time. ○ True ○ False

35. I pay a great deal of attention to changes in my figure. ○ True ○ False

36. While on a diet, if I eat a food that is not allowed, I often then splurge and eat other high calorie foods. ○ True ○ False

## Part II

**DIRECTIONS: Please answer the following questions by filling in the circle above the response that is appropriate to you.**

37. How often are you dieting in a conscious effort to control your weight?

| ○ 1 | ○ 2 | ○ 3 | ○ 4 |
|---|---|---|---|
| rarely | sometimes | usually | always |

38. Would a weight fluctuation of 5 lbs. affect the way you live your life?

| ○ 1 | ○ 2 | ○ 3 | ○ 4 |
|---|---|---|---|
| not at all | slightly | moderately | very much |

39. How often do you feel hungry?

| ○ 1 | ○ 2 | ○ 3 | ○ 4 |
|---|---|---|---|
| only at mealtimes | sometimes between meals | often between meals | almost always |

40. Do your feelings of guilt about overeating help you to control your food intake?

| ○ 1 | ○ 2 | ○ 3 | ○ 4 |
|---|---|---|---|
| never | rarely | often | always |

41. How difficult would it be for you to stop eating halfway through dinner and not eat for the next four hours?

| ○ 1 | ○ 2 | ○ 3 | ○ 4 |
|---|---|---|---|
| easy | slightly difficult | moderately difficult | very difficult |

42. How conscious are you of what you are eating?

| ○ 1 | ○ 2 | ○ 3 | ○ 4 |
|---|---|---|---|
| not at all | slightly | moderately | extremely |

43. How frequently do you avoid 'stocking up' on tempting foods?

| ○ 1 | ○ 2 | ○ 3 | ○ 4 |
|---|---|---|---|
| almost never | seldom | usually | almost always |

44. How likely are you to shop for low calorie foods?

| ○ 1 | ○ 2 | ○ 3 | ○ 4 |
|---|---|---|---|
| unlikely | slightly likely | moderately likely | very likely |

45. Do you ever eat sensibly in front of others and splurge alone?

| ○ 1 | ○ 2 | ○ 3 | ○ 4 |
|---|---|---|---|
| never | rarely | often | always |

46. How likely are you to consciously eat slowly in order to cut down on how much you eat?

| ○ 1 | ○ 2 | ○ 3 | ○ 4 |
|---|---|---|---|
| unlikely | slightly likely | moderately likely | very likely |

47. How frequently do you skip dessert because you are no longer hungry?

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| almost never | seldom a week | at least once a day | almost every day |

48. How likely are you to consciously eat less than you want?

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| unlikely | slightly likely | moderately likely | very likely |

49. Do you go on eating binges though you are not hungry?

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| never | rarely | sometimes | at least once a week |

50. On a scale of 0 to 5, where 0 means no restraint in eating (eating whatever you want) and 5 means total restraint (constantly limiting food intake and never "giving in"), what number would you give yourself?

- 0--eat whatever you want, whenever you want it
- 1--usually eat whatever you want, whenever you want it
- 2--often eat whatever you want, whenever you want it
- 3--often limit food intake, but often "give in"
- 4--usually limit food intake, rarely "give in"
- 5--constantly limiting food intake, never "giving in"

51. To what extent does this statement describe your eating behavior? "I start dieting in the morning but because of any number of things that happen during the day, by evening I have given up and eat what I want, promising myself to start dieting again tomorrow."

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| not like me | little like me | pretty good description of me | describes me perfectly |

## EAH/EPS Adult Form

Please let us know about your eating by putting an "X" and a number in the appropriate boxes.

EXAMPLE

| How often do you... | Never | Rarely | Some-times | Often | Always | On average, how many days a week? (0-7) |
|---|---|---|---|---|---|---|
| ...eat dinner at a restaurant? | | | X | | | 3 |

Imagine that you are eating a meal or snack at home, work, or in a restaurant.
Imagine that you eat enough of your meal so that you are no longer hungry.

| | In this situation, how often do you <u>keep eating</u> because | Never | Rarely | Some-times | Often | Always | On average, how many days a week? (0-7) |
|---|---|---|---|---|---|---|---|
| 1. | ... the food looks, tastes or smells so good? | | | | | | |
| 2. | ... others are still eating? | | | | | | |
| 3. | ... you are feeling sad or depressed? | | | | | | |
| 4. | ... you are feeling bored? | | | | | | |
| 5. | ... you are feeling angry or frustrated? | | | | | | |
| 6. | ... you are feeling tired? | | | | | | |
| 7. | ... you are feeling anxious or nervous? | | | | | | |

Now imagine that you finished eating a meal or snack some time ago and you are not yet hungry.

| | In this situation, how often do you <u>start eating</u> because... | Never | Rarely | Some-times | Often | Always | On average, how many days a week? (0-7) |
|---|---|---|---|---|---|---|---|
| 8. | ...you are near food that looks, tastes or smells so good? | | | | | | |
| 9. | ... you are with other people who are eating? | | | | | | |
| 10. | ... you are feeling sad or depressed? | | | | | | |
| 11. | ... you are feeling bored? | | | | | | |
| 12. | ... you are feeling angry or frustrated? | | | | | | |
| 13. | ... you are feeling tired? | | | | | | |
| 14. | ... you are feeling anxious or nervous | | | | | | |

# EDDS

Please carefully complete all questions.

| Over the past 3 months . . . | Not at all | | Slightly | | Moderately | | Extremely |
|---|---|---|---|---|---|---|---|
| 1. Have you felt fat? | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 2. Have you had a definite fear that you might gain weight or become fat? | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 3. Has your weight influenced how you think about (judge) yourself as a person? | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 4. Has your shape influenced how you think about (judge) yourself as a person? | 0 | 1 | 2 | 3 | 4 | 5 | 6 |

5. During the past 6 months have there been times when you felt you have eaten what other people would regard as an unusually large amount of food (e.g., a quart of ice cream) given the circumstances? YES NO
6. During the times when you ate an unusually large amount of food, did you experience a loss of control (feel you couldn't stop eating or control what or how much you were eating)? YES NO
7. How many DAYS per week on average over the past 6 MONTHS have you eaten an unusually large amount of food and experienced a loss of control? 0 1 2 3 4 5 6 7
8. How many TIMES per week on average over the past 3 MONTHS have you eaten an unusually large amount of food and experienced a loss of control? 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

During these episodes of overeating and loss of control did you . . .

9. Eat much more rapidly than normal? YES NO
10. Eat until you felt uncomfortably full? YES NO
11. Eat large amounts of food when you didn't feel physically hungry? YES NO
12. Eat alone because you were embarrassed by how much you were eating? YES NO
13. Feel disgusted with yourself, depressed, or very guilty after overeating? YES NO
14. Feel very upset about your uncontrollable overeating or resulting weight gain? YES NO

15. How many times per week on average over the past 3 months have you made yourself vomit to prevent weight gain or counteract the effects of eating? 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
16. How many times per week on average over the past 3 months have you used laxatives or diuretics to prevent weight gain or counteract the effects of eating? 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
17. How many times per week on average over the past 3 months have you fasted (skipped at least 2 meals in a row) to prevent weight gain or counteract the effects of eating? 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
18. How many times per week on average over the past 3 months have you engaged in excessive exercise specifically to counteract the effects of overeating episodes? 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

19. How much do you weigh? If uncertain, please give your best estimate. ____lb
20. How tall are you? __ft __in.
21. Over the past 3 months, how many menstrual periods have you missed? 1 2 3 4 *na*
22. Have you been taking birth control pills during the past 3 months? YES NO

---

## YFAS

**This survey asks about your eating habits in the past year. People sometimes have difficulty controlling their intake of certain foods such as:**

- **Sweets like ice cream, chocolate, doughnuts, cookies, cake, candy, ice cream**
- **Starches like white bread, rolls, pasta, and rice**
- **Salty snacks like chips, pretzels, and crackers**
- **Fatty foods like steak, bacon, hamburgers, cheeseburgers, pizza, and French fries**
- **Sugary drinks like soda pop**

**When the following questions ask about "CERTAIN FOODS" please think of ANY food similar to those listed in the food group or ANY OTHER foods you have had a problem with in the past year**

| IN THE PAST 12 MONTHS: | Never | Once a month | 2-4 times a month | 2-3 times a week | 4 or more times or daily |
|---|---|---|---|---|---|
| 1. I find that when I start eating certain foods, I end up eating much more than planned | 0 | 1 | 2 | 3 | 4 |
| 2. I find myself continuing to consume certain foods even though I am no longer hungry | 0 | 1 | 2 | 3 | 4 |
| 3. I eat to the point where I feel physically ill | 0 | 1 | 2 | 3 | 4 |
| 4. Not eating certain types of food or cutting down on certain types of food is something I worry about | 0 | 1 | 2 | 3 | 4 |
| 5. I spend a lot of time feeling sluggish or fatigued from overeating | 0 | 1 | 2 | 3 | 4 |
| 6. I find myself constantly eating certain foods throughout the day | 0 | 1 | 2 | 3 | 4 |
| 7. I find that when certain foods are not available, I will go out of my way to obtain them. For example, I will drive to the store to purchase certain foods even though I have other options available to me at home. | 0 | 1 | 2 | 3 | 4 |
| 8. There have been times when I consumed certain foods so often or in such large quantities that I started to eat food instead of working, spending time with my family or friends, or engaging in other important activities or recreational activities I enjoy. | 0 | 1 | 2 | 3 | 4 |
| 9. There have been times when I consumed certain foods so often or in such large quantities that I spent time dealing with negative feelings from overeating instead of working, spending time with my family or friends, or engaging in other important activities or recreational activities I enjoy. | 0 | 1 | 2 | 3 | 4 |
| 10. There have been times when I avoided professional or social situations where certain foods were available, because I was afraid I would overeat. | 0 | 1 | 2 | 3 | 4 |
| 11. There have been times when I avoided professional or social situations because I was not able to consume certain foods there. | 0 | 1 | 2 | 3 | 4 |
| 12. I have had withdrawal symptoms such as agitation, anxiety, or other physical symptoms when I cut down or stopped eating certain foods. (Please do NOT include withdrawal symptoms caused by cutting down on caffeinated beverages such as soda pop, coffee, tea, energy drinks, etc.) | 0 | 1 | 2 | 3 | 4 |
| 13. I have consumed certain foods to prevent feelings of anxiety, agitation, or other physical symptoms that were developing. (Please do NOT include consumption of caffeinated beverages such as soda pop, coffee, tea, energy drinks, etc.) | 0 | 1 | 2 | 3 | 4 |
| 14. I have found that I have elevated desire for or urges to consume certain foods when I cut down or stop eating them. | 0 | 1 | 2 | 3 | 4 |
| 15. My behavior with respect to food and eating causes significant distress. | 0 | 1 | 2 | 3 | 4 |
| 16. I experience significant problems in my ability to function effectively (daily routine, job/school, social activities, family activities, health difficulties) because of food and eating. | 0 | 1 | 2 | 3 | 4 |

| IN THE PAST 12 MONTHS: | NO | YES |
|---|---|---|
| 17. My food consumption has caused significant psychological problems such as depression, anxiety, self-loathing, or guilt. | 0 | 1 |
| 18. My food consumption has caused significant physical problems or made a physical problem worse. | 0 | 1 |
| 19. I kept consuming the same types of food or the same amount of food even though I was having emotional and/or physical problems. | 0 | 1 |
| 20. Over time, I have found that I need to eat more and more to get the feeling I want, such as reduced negative emotions or increased pleasure. | 0 | 1 |
| 21. I have found that eating the same amount of food does not reduce my negative emotions or increase pleasurable feelings the way it used to. | 0 | 1 |
| 22. I want to cut down or stop eating certain kinds of food. | 0 | 1 |
| 23. I have tried to cut down or stop eating certain kinds of food. | 0 | 1 |
| 24. I have been successful at cutting down or not eating these kinds of food | 0 | 1 |

| 25. How many times in the past year did you try to cut down or stop eating certain foods altogether? | 1 time | 2 times | 3 times | 4 times | 5 or more times |
|---|---|---|---|---|---|

26. Please circle ALL of the following foods you have problems with:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ice cream | Chocolate | Apples | Doughnuts | Broccoli | Cookies | Cake | Candy |
| White Bread | Rolls | Lettuce | Pasta | Strawberries | Rice | Crackers | Chips |
| Pretzels | French Fries | Carrots | Steak | Bananas | Bacon | Hamburgers | Cheese burgers |
| Pizza | Soda Pop | None of the above | | | | | |

27. Please list any other foods that you have problems with that were not previously listed:

## Food Craving Inventory

**Directions:** For each of the foods listed below (Items 1-37), please circle the appropriate letter using the following scale.

**A craving is defined as an intense desire to consume a particular food (or food type) that is difficult to resist.**

Over the past month, how often have you experienced a craving for the food?

A = Never
B = Rarely (once or twice)
C = Sometimes
D = Often
E = Always/almost every day

| | |
|---|---|
| 1. Cake | A B C D E |
| 2. Pizza | A B C D E |
| 3. Fried Chicken | A B C D E |
| 4. Gravy | A B C D E |
| 5. Sandwich Bread | A B C D E |
| 6. Sausage | A B C D E |
| 7. Pudding | A B C D E |
| 8. French Fries | A B C D E |
| 9. Cinnamon Roles | A B C D E |
| 10. Rice | A B C D E |
| 11. Hot dog | A B C D E |
| 12. Peanut butter | A B C D E |
| 13. Hamburger | A B C D E |
| 14. Biscuits | A B C D E |
| 15. Ice cream | A B C D E |
| 16. Pasta | A B C D E |
| 17. Fried fish | A B C D E |
| 18. Whole milk | A B C D E |
| 19. Cookies | A B C D E |
| 20. Chocolate | A B C D E |
| 21. Pancakes or waffles | A B C D E |
| 22. Corn bread | A B C D E |
| 23. Chips | A B C D E |
| 24. Butter or margarine | A B C D E |
| 25. Rolls | A B C D E |
| 26. Cereal | A B C D E |
| 27. Donuts | A B C D E |
| 28. Candy | A B C D E |

| | |
|---|---|
| 29. Brownies | A B C D E |
| 30. Bacon | A B C D E |
| 31. Croissant | A B C D E |
| 32. Steak | A B C D E |
| 33. Pie | A B C D E |
| 34. Baked potato | A B C D E |
| 35. Barbecued ribs | A B C D E |
| 36. Mashed potatoes | A B C D E |
| 37. Bagel | A B C D E |

**Factor loadings for the FCI are as follows:**

**High Fats:** Fried chicken, Gravy, Sausage, Hot dog, Fried fish, Corn bread, Bacon, Steak

**Sweets:** Cake, Cinnamon Rolls, Ice cream, Cookies, Chocolate, Donuts, Candy, Brownies

**Carbohydrates/Starches:** Sandwich bread, Rice, Biscuits, Pasta, Pancakes or waffles, Rolls, Cereal, Baked potato

**Fast Food Fats:** Pizza, French fries, Hamburger, Chips

**FOR OFFICE USE ONLY**

**Group:** **H** **O**
**Condition:** **C** **A**

**Code:** _____

**Packet Reviewed for Completion:** **Initials:** _____
**Date:** _____

**Food Rating– Baseline**

PICTURE : □ 1 □ 2 □ 3 □ 4 □ 5 □ 6 □ 7 □ 8

(please mark the number above that matches the picture in front of you)

1. How much do you **<u>like</u>** to eat the food in the picture in front of you?

_____

(not at all) (extremely)

2. How much do you **<u>want</u>** to eat the food in the picture in front of you?

_____

(not at all) (extremely)

3. How pleasant do you find the food in the picture in front of you?

_____

(not at all) (extremely)

**Food Rating– Taste Test**

TASTE TEST FOOD ITEM : A B C D
(please circle the letter above that matches the letter on the bowl)

1. How sweet is the food that you are eating?

(not at all) (extremely)

2. How flavorful is the food that you are eating?

(not at all) (extremely)

3. How much do you **like** the food that you are eating?

(not at all) (extremely)

4. How much do you **want** the food that you are eating?

(not at all strong) (extremely strong)

5. How much does the smell of the food you are eating influence your desire to eat the food?

(not at all) (extremely)

6. How much does the smell of the food you are eating influence the amount that you are eating?

(not at all) (extremely)

**Hunger, Fullness, and Craving Rating Sheet**

VAS: □ BL □ ARpre □ ARpost □ TTpre □ TTpost

**Please mark on the line the location that corresponds with 'How you feel at this moment.'**

1. To what degree do you experience hunger at this moment?

(no hunger) _____ (extreme hunger)

2. How full does your stomach feel at this moment?

(not at all full) _____ (extremely full)

3. How much would you like to eat at this moment?

(none) _____ (a very large amount)

4. How strong is your craving for food at this moment?

(not at all) _____ (very strong)

**Picture Stimulus Rating Instructions**

Please take a few minutes to review the images presented to you on the screen. Each of these images was shown to you during the computer tasks you completed today.

You will be shown each image individually and be asked to rate each image on how pleasant you found the image to be.

You will be provided a line on which you can indicate your response.

You can rate images from 0 (very unpleasant) to 100 (very pleasant).

Please make sure that you rate each image. You will not be allowed to continue to the next image until you enter a number between 0 and 100 (integers only, no fractions).

**Check-out Questionnaire (to be completed before debrief)**

The purpose of the present study was most likely: (**PLEASE CHECK ONE**)

1. To examine the effects of task performance on eating _____
2. To examine the effects of appetite on task performance ____
3. To examine the effects of hunger on food intake ____
4. To examine the effects of task performance on hunger ____
5. To examine the effects of attention to food cues on food intake _____
6. To examine the effects of food craving on taste _____
7. Other ? _____

How many calories do you think you consumed? _____

**Appendix G: Participation Debriefing Form**

**Purpose of Project: Retraining Attention Bias to Unhealthy Food Cues**
**Principal Investigator: Elena A. Spieker, M.S.**

**TO PERSONS WHO AGREED TO PARTICIPATE IN THIS STUDY:**

As noted in the original consent form you signed at the beginning of this study, the full intent of the study was not explained to you until after the completion of your participation. The following information is provided to inform you about true purpose of the research project and your participation in it. Please read this form carefully and feel free to ask any questions you may have about this study and/or about the information given below.

If, after consideration of the true nature of this study or the use of less than full disclosure, you should have any questions about the study or your participation in it, you may contact:

**Elena Spieker, M.S. at 410-575-4009**
Department of Medical & Clinical Psychology, USUHS, Bethesda, MD 20814-4799

**Tracy Sbrocco, Ph.D. at 301-295-9674**
Department of Medical & Clinical Psychology, USUHS, Bethesda, MD 20814-4799

**Office of Research at (301) 295-3303**
USUHS, Bethesda, Maryland 20814

Thank you for your participation in our study. Your participation is important to us and we know that it takes time and energy to be involved. We appreciate your efforts. We recruited you to participate in a study on attention to food and appetite, and we noted in the consent form that additional details about the background and tasks would be disclosed following study completion.

In addition to an interest in learning about the role of attention to food cues when people are satiated, we are specifically interested in understanding how people of different body weights respond to pictures of food shortly after they have eaten a meal when they do not report that they are hungry. Further, we wanted to test whether computer training can reduce attention to high-calorie food images and see if people who received the training in the study ate less, reported less craving for food, or performed differently on the tasks compared to people who did not receive the training. Understanding why pictures of food can affect eating behavior and food craving even when we are not hungry is very important because of all the high calorie foods that are not only available but widely advertised. This study was designed to look at how environmental images that are related to foods high in fat and sugar impact attention to food cues, craving for food, and how much is eaten when food is available.

We expected that body weight would be related to task performance. Previous research has shown that individuals who are overweight and obese pay more attention to food cues, especially high-calorie food cues, than non-overweight individuals do. This relationship between body weight and attention to high-calorie food cues is present even following food intake, in the absence of internal hunger. This shows how strong external cues in the environment can be for many of us. Additional research has shown that enhanced attention to high-calorie food cues is directly related to increased food craving and food intake.

In order to see if attention to food cues differs by body weight we recruited female participants in a wide weight range. When we analyze our data one of the things we will look at is whether there are differences between participants of different body weights. Other variables of interest include eating behaviors, age, race, education, and food cravings. The second question we wanted to answer in this study was whether attention to high-calorie food cues can be modified, hopefully reduced since no one in this study was hungry when they completed the attention tasks, by completing attentional retraining.

One half of participants in the study completed a task that trained attention away from high-calorie food pictures and focused attention toward healthy pictures and the other half completed a 'control' task that directed attention equally toward healthy and unhealthy food pictures (no-training). You had equal chance of being in either the retraining or the control condition and group selection was random, like flipping a coin. It is important that we had both groups in this study so that we could determine to the best of our ability that any differences between groups in our pre-training and post-training measurements of hunger or food craving or differences in food intake between the control condition and the retraining condition were not simply due to chance.

We think that eating may be affected by attention to food cues for some people and we wanted to know if attentional retraining could reduce taste test food intake. This question hasn't been addressed in previous research. Single session attentional retraining has been shown to reduce smoking and alcohol intake in the laboratory. Attentional retraining has also improved self-esteem and reduced body consciousness among females in a single training session. We will examine whether attention to food-related cues, hunger, food craving, and food intake differ between obese and non-overweight women and between women in the attentional retraining and no-attentional retraining (control) conditions.

Finally, we told you the purpose of the taste test was to taste and rate four snack foods. We did not tell you that the amount you ate was to be measured and the true purpose of the taste test was to compare snack food intake among women in the attentional retraining and no-retraining conditions. We didn't tell you that we were measuring the amount you ate because often people feel uncomfortable eating when they know that the amount they eat is being monitored. We wanted to make this as true to real-life as possible. In other words, we wanted you to eat what you felt like eating, without feeling embarrassed, worried or concerned about what we were measuring. The amount of food eaten by people assigned to the different training conditions will be compared to help us understand whether attentional retraining affects acute snack food intake. The specific

amount of food you ate will not be analyzed separately—rather your data will be combined with all the other individuals in this experiment to make general statements about eating and attentional retraining. Retraining attention may provide new treatment possibilities for weight management or preventive strategies for individuals at-risk of overeating.

Should you have any questions at any time about the study you may contact the principal investigator, Elena Spieker, M.S., Department of Medical & Clinical Psychology, USUHS, Bethesda, MD 20814-4799, at 410-575-4009.

Thank you for your participation.

Sincerely,

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